MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF AN APPLICATION BY CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES FOR THE PURPOSE OF THE PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.

March 8, 1975.

PROCEEDINGS AT INQUIRY

VOLUME XIV

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APPEARANCES:

Mr. Ian G. Scott, Q.C. Mr. Stephen T. Goudge, Mr. Alick Ryder and Mr. Ian Roland	for Mackenzie Valley Pipeline Enquiry;
Mr. Pierre Genest, Q.C. Mr. Jack Marshall, Mr. Darryl Carter, and Mr. John Steeves	for Canadian Arctic Gas Pipeline Limited;
Mr. Reginald Gibbs Q.C. Mr. Alan Hollingworth	for Foothills Pipelines Ltd.;
Mr. Russell Anthony, Prof. Alastair Lucas & Dr. Andrew Thompson	for Canadian Arctic Resources Committee;
Mr. Glen W. Bell and Mr. Gerry Sutton	for Northwest Territories Indian Brotherhood and Metis Association of the Northwest Territories;
Mr. John U. Bayly	for Inuit Tapirisat of Canada and the Committee for Original Peoples' Entitlement;
Mr. Ron Veale and Mr. Allan Luke	for Yukon Native Brotherhood;
Mr. Carson H. Templeton	for Environment Protection Board;
Mr. David Reesor	for Northwest Territories Association of Municipalities
Mr. Murray Sigler	Northwest Territories Chamber of Commerce

I N D E X

Yellowknife, N.W.T.
March 8, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

CHARLES DAVID BAILEY, sworn:

THE SECRETARY: State your full name, please.

A Charles David Bailey.

DIRECT EXAMINATION BY MR. SCOTT:

Q Mr. Bailey, I understand that you're a registered civil engineer in British Columbia, Quebec and Ontario.

A Yes sir.

Q And you are a graduate of the Royal Technical College in Glasgow, which is now Strathcona University.

A Yes sir.

Q That you're a registered civil engineer in the State of California, as well.

A Yes, I am.

Q And a life member of the Engineering Institute of Canada.

A Yes.

Q A Fellow of the American Society of Civil Engineers.

A Yes.

Q And I understand also that you were the former chairman of the Test Committee, C.S.A. Pipeline Code.

A Yes, I was.

Q I understand that for a period of time from 1964 to 1970 you were the chairman of the Board of Consultants of the Bechtol Corporation?

A Yes, that was in the City of San Francisco.

Q What do they do?

A I think the main function of the Board there was to make certain that the task, contemplated task facing Bechtol was within their competence; and secondly, to make certain that it was inherently a good undertaking of the company, and for the country in which it was located.

Q And what is your present occupation?

A I'm consultant with H.A. Simons, a firm of civil engineers and consulting engineers in the City of Vancouver, and other parts of Canada.

Q And Mr. Bailey, have you had any particular consulting function from time to time, or done any work in northern areas?

A Yes, I have.

Q What is that?

A I was responsible as chairman with Bechtol for the design of the test station at Inuvik in the north up here.

Q Well now, Mr. Bailey, if you'd like to carry on with your presentation we would be grateful.

A Thank you.

Mr. Commissioner, it appeared to me that the description of the natural gas industry which was a subject selected by the Inquiry, could be addressed or dedicated to the human and other life continuing within the areas of the valley of the Mackenzie Valley or the Mackenzie River, and the entry of the river into the Beaufort Sea, and the coastal reaches fronting on that sea. If this is acceptable to you, it involves my view of the climatic and other factors of life support of the regions with the conclusion that life, while perhaps not abundant, can be both favored and rewarding within the valley.

Old and new cultures can be developed by the people and contributions can be made by them towards the development of others. It would appear that human life within the valley must be more dependent than elsewhere on the continuation of an indigenous life forms -- the plants, the fish, the birds, the animals -- that the remarkable climate within the envelopment of the area by the 50 degree Fahrenheit isotherm makes it a practical and to many a very desirable place in which to live.

Therefore before coming to the subject, perhaps you would permit me a parable. In Teheran in Persia, which is another oil and gas area of the world, it formerly was pleasant in the dusk of the evening to sit in good company among the gardens of the city and to listen to nightingales sing. This bird, with a habitat ranging across the western Europe to the British Isles, has a singular purity of

song. There are no longer nightingales in Teheran. The noise and exhaust of automobiles and the emissions of industrial plants have forced replacement of the music by that provided by transistor radios. The birds of the Mackenzie are different to the nightingale in responsibility, in determination and courage, but all Canadians share their need for survival.

Natural gas. The land and sea covered by the scope of this Inquiry contains reserves of natural gas which may prove to be substantial. Analysis of the gas already discovered show that it is of great purity, and value in keeping with the north. What is this gas? And how did it accumulate where it has been found?

The amended National Energy Board Act of 1969 and '70, C-65 has two definitions of natural gas, Part I:

> "Gas, except for the purposes of Part 6, means natural gas or other hydro-carbon or other mixture of hydro-carbons that is in a gaseous state."

Part 6 states:

> "Gas means natural gas or any fluid hydro-carbon, or any fluid mixture of hydro-carbon other than oil."

Although in many countries natural gas is considered to be simply the gaseous phase of crude oil. The Canadian legal definition of something other than oil is logical for a number of reasons. One of these is that sub-surface accumulations of natural gas, not apparently related to liquid oil accumulations are known in many parts of the world. There is some evidence that gas accumulated later than oil and that it is of biogenic origin with sources in the great masses of vegetable matter deposited in the depths of the seas.

Oil is considered to have its source in marine and land animal matter. Gas appears to have formed after the formation of oil and to have migratrated from a wider distribution of very minor quantities to concentrations where it became entrapped and sealed. May I have slide one.

In this slide is a typical textbook illustration of a gas resevoir and indicates that a drive of water up through the permeable layer of sedimentary rock pressed the gas and oil upwards until the gas was retained by the caprock above it and in this particular slide it is shown in conjunction with oil, but it could very well be alone as simply a gas reservoir.

The evidence shows that anerobic micro-organisms assisted in the formation of the gas from the decomposition of the dead plants and marine matter lying under the seas and that the gas was actually formed in strata and deposited

by the sea, that is, this anerobic treatment of the vegetable matter really means that a very elementary form of life bacteria digested the vegetable matter and they died and were replaced by following bacteria for hundreds and thousands of years until the gas was formed, and entrained in strata being deposited by the solids from the sea which form the rock strata.

The pores of these rocks originally contained salty sea water, so the first globules of gas therefore had to be about the same size as the space between the mineral grains forming the rock. A drive was required to move the gas through the rock, the permeability of which required greater force than simple gravitational bouyancy and the industry believes that the compaction of the water, subterranean water, by the folding of the strata caused, gave the pressure to supply the drive.

Slide two. This is another entrapment of oil shown here, but it could be gas formed by a shift in the structure of the underground sedimentary rock, where the section on the right hand side of the line has been upthrown and cut off the permeable channel and sealed it and this is a rather difficult reservoir to find, but a very productive one. The gas was contained within these sealed chambers for a time estimated to run from 100 to 500 million years. A very long time indeed. And there does not appear to be any material change in the gas during that time other than the presence of minor

quantities of CO_2 and nitrogen suggests that perhaps some air did get into the strata and caused some oxidation of the methane which is the principle constituant of the natural gas.

All of the hydrocarbons in natural gas are flammable and all the members of the paraffins series, the same series.

Could I have the next slide. The largest component of gas is methane which varies between 70 and 95% as a rule, ethane, propane and isobutane , a normal butane, all of these fractions up to that point have a negative boiling point on the centigrade scale and all are gaseous at normal temperature and pressure. The other constituants other pariffins acopentane, normal pentane, normal hexane, normal hectane and lighter elements, are liquid at normal temperature and pressure and have a positive boiling point on the Centigrade scale.

Natural gas must have accumulated during the later geological stages of the oil accumulation, 100 to 500 million years ago, but only after the consolidation of the containing strata and after the caprocks were there to provide for its preservation, where oil contains associated natural gas, this almost certainly occurs by saturation of the oil through its contact with the gas,

through the contact phase. When we shall know with certainty and where gas was formed is problematical. The origin appears to be different from the origin of oil, although perhaps there is an association. The natural gases of the Arctic are those which will materially interest us this morning are shown on slide No. 4.

Two of these analysis are from wells within the delta, Tagloo and Nigligtak and they show gas of extreme purity, there's practically nothing in it but methane. In Nigligtak gas there's 98% methane, perfectly sweet, dry gas, not very much in the way of liquids to be removed, useful liquids to be removed.

The gas in the polar area on the islands is the third column, and it similarly is a high purity, extremely valuable gas. The gas from Prudhoe Bay is associated gas, that is it's produced with the oil and it shows quite a different picture really. It shows a good deal of liquids and a high CO-2, and some H2S but not enough to make it a sour gas. So these are the gases that we expect may be produced within the Territory.

The gas from the high Arctic is a sample taken from a well on Ellesmere Island, quite a recent well. Industry uses many terms for gas in its transformations from the well until it reaches the consumer, and perhaps it would be a good thing for me to just list them off in their classification with perhaps some minor explanation.

Dry gas is a gas very similar to the delta gas, and it's principally a cap gas, that is it comes out of a cap, not with oil but by itself.

Wet gas is a good gas but carrying condensates with it.

Sour gas is a gas containing hydrogen sulphide.

Dissolved gas is a gas which is contained inside oil in a crude oil reservoir.

Associated gas is a gas produced somewhat from our reservoir shown in slide 1, where the gas not only was -- had a cap gas arrangement but also saturated the crude oil.

Raw gas is a gas that comes out of the well, without any treatment.

Residue gas is a gas leaving the process plant which cleans up the gas and prepares it for the pipeline. We call it the same gas, call it pipeline quality gas.

Natural gas as it is distributed to the consumer.

Mr. Commissioner, there are a number of analysis of different gases contained in my paper, but they're more useful, I suggest, to the record than in a talk, and if I may just pass over them? Thank you.

THE COMMISSIONER: You have turned your paper in to Mr. Scott, I take it?

A Yes.

Natural gas is colorless, it's odorless, it's non-toxic, and it's lighter than air. This is generally received by the distribution system which brings it to your kitchen stove or heater. The gas makeup may change a little if a proportion of it is turned into LNG or liquified natural gas, as a storage in the distribution system, or it may change a little, if there's any super drying of the gas to take out all of the liquids that it contains. In normal -- normally in Canada we add an odorant to the gas so that its presence can be detected if you enter a space containing gas.

There are certain safety considerations with natural gas, as with any flammable material, and they are related to its ignition temperature, its explosive limits, and its specific gravity, whether it will rise in the air or not. It ignites at 1185 degrees Fahrenheit, which can be achieved by a match or an electric spark or a static spark, or a lighted cigarette, or the elements of a hot car exhaust. It explodes when 4% of natural gas is contained in air. That's it's lower limit, and it's upper limit is when 16% of natural gas is contained in air.

The normal specific gravity of natural gas is about .55 to about .75 related to air, and that means that if the room is ventilated or the space is ventilated, the gas will rise to the upper part of the room and pass outside. In a basement that can't happen. While it is non-toxic, it can't support life because it contains no oxygen

and it would be very dangerous to be inside of a room or space occupied largely by gas.

Appreciation of gas as a natural resource. Natural gas today satisfies about one-fourth of the total Canadian energy requirements. The established original reserves, that is the amount of gas that's been measured, proved to be there, and lies within the economic transportation of a market was about 135 trillion cubic feet, of which it was believed originally that about 80 trillion cubic feet could be produced and ultimately recovered. 20 trillion cubic feet have already been produced, or a quarter of the established produceable total. From 55 to 60 trillion cubic feet remain. The current rate of production is about 2 1/2 trillion cubic feet per year, which suggests a life expectancy of about 20 years at this time.

It is a little difficult to think of a trillion, you know. It is to me, it is such a large unit, 10^{12}. The size is really a little incomprehensible, but as an example if you could pack natural gas into cubic feet, just a little parcel 12 inches wide and 12 inches long and twelve inches high and then took a trillion of them and built them into larger blocks of a cubic mile, that is a mile wide and a mile high and a mile long, there would be about seven of these cubic miles to contain a trillion cubic feet.

The frontier reserves which are not included in the Canadian producable reserves at this time are located in the Arctic, the Canadian Arctic, offshore east and offshore west and they are speculatively believed to have a potential greater than 300,000,000,000 cubic feet in place. Very much larger and more impressive figures have been advanced by a number of authorities but this is the lowest of these available to me. Using a 60% recovery factor it is possible that the recoverable volume of about 180 trillion cubic feet may be established to add to the present reserves, hopefully within the next ten to fifteen years.

When and if this occurs Canada may have 240 trillion cubic feet of recoverable reserves which are capable of development at annual rates increasing in ten to fifteen years to perhaps 5 trillion cubic feet per year, or about twice the present production. Including possibly 1 trillion

cubic feet for export as at present. This annual production would permit gas supplies for about 45 years. Evaluation of five trillion cubic feet per year at $1 per M.C.F. -- an M.C.F. is another term used by the gas people and it means a thousand cubic feet or about 1 million B.T.U.'s. The evaluation of five trillino cubic feet which has been mentioned would be about $5 billion annually, but a possible -- that $1 figure, by the way is the present export price which is, I understand a temporary price and it is contemplated that it will rise quite quickly -- would be 5 billions with a possible future value maybe about 9 billions of dollars. Will this would be beneficial to us. It is vital to our energy requirements and I believe that it will benefit all of us.

How to use this gas. There is disagreement among Canadians on the best use of the resource. Presently it is mainly burned as a fuel and produces heat and power in many forms. A minor opinion considers this wasteful, but with maximum attainable efficiencies of conversion of around 30%, the conversions of all fuels are about -- must be considered equally wasteful. Gas has such singular cleanliness advantages, of cleanliness of emission and convenience, but the probability is for continued use as a fuel for residential and industrial needs for generation of power, when economics permit and supplies are available and increasingly for petrochemical resolution into fertilizers, textiles and chemicals. All of us

know the fertilizers that are so abundantly produced today, ammonia, nitrogen and uria and many of us where clothes spun from the polyfibres which have such special advantages and the petrachemicals are legion in their number.

Natural gas is a valuable resource of Canada. It is inevitably subject to depletion and requires wise administration in its use. So even with the greatly added reserves which are in contemplation, the very most that we can see is that the gas will last for 40 or 50 years.

Slide number six, Tom, please. I think that is five -- oh, what is shown here is the value of various sections of Canadian industry compared with natural gas and this year it is expected that about 2 and a quarter billion dollars worth of gas will be marketed, comparing with the 3 billion dollars for the steel and iron industry and 5 and a half billion dollars for the mining industry and of course the enormous manufacturing total of 48 billion dollars. The pulp and paper industry is about 6 billion dollars or about three times the size of the value of the gas industry, but you can see that it is quite an important contribution.

The division --

THE COMMISSIONER: Excuse me, Dr. Bailey. Is it not possible for that door to be kept open or closed instead of it banging every few minutes? Forgive me --

A No, there is no difficulty at all -- there are three main divisions in the industry: production, transmission and distribution and the division of the annual value of the industry into these branches is about 30% to production, which averages in Canada now is about 25¢ a thousand cubic feet and 30¢ to transmission, based on about a 600 mile transmission, such as the West Coast and 33¢ distribution which is the most expensive and uses the most people and forms 40% of the total value.

One of the problems for speculation is what effect of the more expensive gases from the Arctic and from the other sources expected to produce gas -- what the effect is going to be with the present gas produced in the provinces to the south. If we could speculate on that for a moment and could I have slide number eight.

LEt us assume that the wellhead price of delta gas in 1980 is 90¢ per M.C.F. -- per thousand cubic feet -- on a residue basis, that is after preparation and that transmission cost to the fiftieth parallel, almost to the U.S. border are a $1.10. It would appear that the price of Arctic gas at this new destination might be $2.00 per thousand which is a very high figure and its equivalent related to crude oil is about $12.60 a barrel which is about the price of it as it is sold offshore by Canada at the moment.

THE COMMISSIONER: Excuse me,

offshore, did you say offshore sales, offshore to Canada or by Canada?

A By Canada.

THE COMMISSIONER: Yes.

A The Canadian export price is about twice the present.

THE COMMISSIONER: Yes --

A But I am speaking of five years from now and at the great costs involved for arctic work

Well, gas produced in the prairie provinces at the same time, that is in 1980 and carried to about the same delivery point might be priced about $1.40 to $1.70 or an oil equivalent of about $9.45 a barrel. The total national production in 1980 could be 3 trillion cubic feet, formed of 1 trillion cubic feet from the frontier areas, and that is possibly from the delta and from the polar system and the reduced 2 trillion feet from the provinces. The value of the total production would therefore be $5 billion a year and the average price of the mix would be about $1.67 per m.c.f. In 1985 with 4 trillion cubic feet marketed, the value could be $7 billion, at an average price of about $1.75 because of the larger proportion of frontier gas. The make up of the 4 trillion I have assumed for 1985 is 2 trillion from the frontiers with the provincial production holding at the same figure.

The extra cost of the frontier gas on the whole volume is about 25¢ per m.c.f

which is a very moderate figure in my opinion.

I think that it is most important to preserve these differences and I think that their preservation will be a credit to the wisdom of the southern producers and will remove any problem to the industry or to government in handling two or more prices.

Mr. Commissioner, Dr. Hamelin spoke yesterday of the assistance expected in the deficit position of the territories, the financial position and I looked at that, following his address and his figures appear to line up fairly well wth with my assumptions. The royalties resulting from a billion cubic feet of gas produced within the Territory, that is, not the United States gas, but the just the production here, would amount to about 55 million dollars a year and with 2 billion cubic feet which I think hoped for, would be about $110 million a year in royalty and this would leave the producer 75¢ for his work which I estimate would permit an expenditure of 1 and 3/4 billion dollars in discovery and production.

The history of the industry. Natural gas has been in place a great deal longer than man has been on earth. We find remarkably few historical references available to us. There are instances of eternal flames within human race memory, and in Bakow near the Caspian Sea, there was a temple or a former temple which existed from pre-Christian times until about the year 1900. This temple honored or protected a gas flare. In addition, the tradition of burning springs has perpetuated in a number of North American place names. The first practical use of natural gas was probably by the Chinese during the Sho Han Dynasty, early in the third century A.D. The gas was used as a cooking fuel and was transported from shallow wells and seepages through pipelines of bamboo with some compression by hand bellows.

Dr.Torreso mentions a small scale local use in Northern Italy in the 17th century, and also the first known commercial application by William Hart of Predonia, New York, in 1820. Hart's well found gas at 27 feet and supplied some 30 consumers with fuel and light.

Rapid development took place in the United States after that date, including the overland piping of natural gas to the City of Pittsburgh in 1883. By 1890 there were 500 miles of natural gas mains in the City of Pittsburgh.

In Lemmington, Ontario, and the surrounding districts, an established producing and distribution system was operating in 1889 and at

Medicine Hat in 1890. I understand one of the original Medicine Hat wells i s still producing.

Thereafter, the natural gas industry expanded rapidly in many countries, particularly after the successful development of welded pipelines in 1920, but dynamic change in the scope of the industry followed the metallurgical and technical development of big inch pipelines, 24-inch, 36, in the 1940's. These large diameter pipelines virtually made it possible, reliable and economic to transport gas to a market located thousands of miles from the well. During the 1960's it was possible to move 1,000 cubic feet, 1 M.C.F. for 100 miles at a cost of 7/10ths of 1¢.

I'm going to stretch my subject unduly to tell you of the great natural gas discoveries in Russia and North Africa, Gonagin(?) and the Netherlands and the British North Sea and elsewhere. The remarkable speed with which the gas was put to work is a stirring achievement by very many different peoples working together.

In Canada the momentous discovery of oil at Leduc, Alberta, and later elsewhere in the province in 1947 created a great new activity of exploration in the Prairie Provinces, and in British Columbia, and in searching for oil, important volumes of natural gas were discovered in place.

The Westcoast Transmission 30-inch pipeline was built in 1957, and began operation to export Peace River natural gas to the Pacific North-

west of the United States, and to supply, through distribution companies, the then less of a domestic market was in British Columbia. Almost at the same time the evolution of the principles of the Alberta Gas Trunk Pipeline began, primarily, I believe, to ensure that all reasonable needs of the people and the industries of Alberta were met and satisfied before any gas left the province for either the United States or Eastern Canada.

This company at that time was designed to protect and transport gas from various shippers and to restore custody to the owners at the provincial border crossings. With its principles established in law and part of the trunk system installed in 1957, the building of the Trans-Canada Pipeline took place, and that system entered service in 1958. The Trans-Canada Pipeline system is at present the greatest of all natural gas pipelines, in length and capacity and in performance.

The provision of these three services, Westcoast, Alberta Gas Trunk, and Trans-Canada, had a profound effect on production and sales distribution of natural gas across Canada from Vancouver to Montreal. The effect on the Canadian economy was of equal importance. It should be noted at this time that the three systems mentioned were not planned to distribute or to sell gas to consumers, but instead to deliver, and in certain cases, to sell to secondary pipeline companies, to regional distribution systems and to U.S. pipeline networks.

This planning changed in 1974 when Westcoast became substantially a cost of service system transporting only gas owned by a B.C. Crown corporation, which now makes sales and establishes prices.

How has the industry performed? Since these dates around 1957 and 1958, I must say that certain aspects of performance have been good. The corporate care of the land utilized for wells, process plants and pipelines has generally been faithful to the spirit of agreements made. The record with labor is probably as good as the best during the last 25 years, and conflict, with disturbance to service through labor difficulties has not occurred. The industry is not labor-intensive, therefore it has been possible to maintain levels of wages and other remuneration which, while related to the levels in localities, were certainly the best available. As a consequence, standards of skill and dependability of the men and women involved in the industry are very high. Access to the better jobs of responsibility within the industry has not been unduly difficult, and remarkable records of individual achievements are reasonably frequent.

A constructive criticism of the overall direction of the industry may be made, however, and we refer to the general lack of long-range understanding of the problems latent to the business. Because of the effect of the monopolies created by the unity of the producers, the charters of the pipeline companies, and the public utility nature of the

distributors, the natural resource has been handled as required by the vice-presidents in charge of sales, that is it has been based only on the upward thrust on a sales map.

Exploit and export. The ultimate depletion of the resource and related essentiality of the husbanding of supply has been a secondary and secret matter, at least it has been until curtailment of contract volumes have brought the picture into the open. I have a cutting here where Trans-Canada, making a presentation to the National Energy Board, estimates that it will be short 40 billion cubic feet by the winter of 1975-76, and that this shortage would increase to 142 billion cubic feet by 1981.

Great volumes of gas have been exported at prices which paid only slightly more than the interest on the construction bonds. The general price level of the domestic sales of gas has been low enough to cause an expansion of distribution which may not be maintained in the future. The reduction of discovery of new accumulations in the provinces may in fact be due to the scarcity of promising points of search, as much as any other reason.

The profitability of the industry. The records of year to year trading of most natural gas companies appear to show, in a minor way, a profitable history. Average net earnings declared run between 4 and 6% on the value of the particular assets involved. Stock dividends from these earnings have varied from 50 to 75% of the net earnings.

Stockholders would have experienced a very thin time but for the leverage of the debt equity ratios involved, usually about 2.5 to 1. The regulated rates of return, which are being handed down by the regulating bodies are now approaching about 10% of the rate base. The rate base is the value of the facilities used to earn the money. The rate base rate of return of 10% involves the servicing of debt. The debt of the industry in the aggregate is an enormous sum, and while it is rated secure, the bonds are generally very long-term, with some maturing about the turn of the century.

The future profitability of the industry is dependent on a continued supply of the natural resource, and therefore on further reserve discoveries. The industry must therefore provide out of present revenues the funds required to cover exploration and discovery costs necessary to ensure this future supply. Profits should therefore be viewed in terms of today's cost of equipment and construction. The industry has almost universally and perfectly legally depreciated its main assets at 2% straight line, giving a 50-year life basis. However, the fact is that at present, on a replacement consideration this 2% depreciation rate is on the basis of 112 years life, as costs have escalated approximately 2 and a quarter times. 112-year life span is absurd for two reasons:

- The pipelines and the equipment will not enjoy such a life, and
- There is very little likelihood of natural gas

reserves lasting for that time.

The industry therefore must consider a depreciation rate of about 2 1/2 times the present provisions, or something close to 5%. Under these conditions it's questionable whether any true profits are ever made at all in past years. We've actually been living off the investment. Therefore in order to provide funds for the future, based on today's costs, and to maintain the same profitability currently being reported, the depreciation rate involves an increase in gross revenues. As an example, at the old prices an increased selling price of gas at the international boundary of about 2¢ per M.C.F.

I should emphasize that an increase in the depreciation rate and the resultant increase in selling price does not increase profits itself. It tends to secure a real profit and to provide cash liquidity to the industry, both of which are required if the industry is to maintain a continuous supply.

In the past had such policies been in effect, the industry would have been in a proper cash basis for the provision of future supply and for the reduction of debt. Employment provided by the industry -- the number of employees in all of the industry is not very large, about 25,500 men and women, constituting about a quarter of 1% of the present Canadian labor force of nine million people.

When the frontier gas becomes available, when and if it becomes available, so that the national marketed volume of natural gas is about four trillion cubic feet, perhaps in ten years, the industry employees may total about 38,700 men and women, about 13,000 more than now, and about .4 of 1% of a Canadian labour force of 10 million people at that time.

The distribution of the workers in the three main branches indicate that about 22% of them are in the production department, 24% in transmission, and 54% in distribution.

The regulation of the industry. Generally in Canada the industry is regulated by the National Energy Board of Canada, and by Public Utility Commissions for distribution. In Alberta, where most Canadian natural gas originates, production and export from the province is controlled by the Energy Resource & Conservation Board of Alberta. In British Columbia, production and exploration is under the control of the Minister of Mines, and transmission under the Department of Commercial Transport, and the utilities under the B.C.

Energy Commission.

In the United States, inter-state trade in natural gas is closely regulated by the Federal Power Commission, who also must approve volumes and prices of import. This slide shows the gas volumes which have been produced and which I estimate will be produced in the future, and the value in the second column. The third column in the grey shade shows the number of industry employees, and the fourth column is the number of people who live -- whose living costs are paid for out of the cheques, the pay cheques of the people in column 3. There are estimated to be five per employee, that is a man, his wife, his children and all of the services that are associated with making that life possible. These are the Canada Statistics work force of Canada for the years up to 1975, say, and the population, with estimated figures beyond that. You can see from this that this year about 2 1/2% of the gross national product, of all of the wealth that's produced in Canada during the year, will be produced by some 25,500 people who form about half of 1% of the population.

The table indicates that up to 1975 the industry clearly contributed its share of the national production of wealth and we hope that in later years that it will show continuing improvement. Another consideration, of course, in this production of wealth is that the industry contols the greatest per capita investment of equipment and instrumentation in the nation, and the productivity of the employees

should therefore be very high, which it certainly appears to be.

The exploration and discovery of producable natural gas. Apart from the investigation of surface shows of oil and gas, which may occur by the fracture of a sub-surface reservoir through earth movements, the modern exploration is an involved and time-taking process. Tremendous work and notes of the Canadian Geological Survey have played a great part in indicating regions where discoveries are a possibility. But a series of other surveys are required, including perhaps the first, an air reconnaissance survey and air photography. These are really essential to today's exploration and may furnish valuable photo-geological interpretations to confirm the later selection of a drill site.

Gravity surveys, which, generally speaking, I think, are made in the north by means of aircraft, they measure the increases and decreases of the earth's gravitational field and provide enlightenment on what lies below the surface. When a great number of gravity readings are taken, and digested and placed on photo maps, it is possible to draw some sub-surface contours, using the actual gravity lines which these points produce. The interpretation of the contours is a dicey affair on land and twice as difficult when over water. Before commitment to drilling is made, promising areas are more closely scrutinized by seismic survey. See slides 9 and 10 now.

This is a seismic crew

drilling to place a shot in the shot-hole and I think the next slide shows the shot actually taking place. This method of exploration involves back-breaking efforts by highly trained crews and utilizes the effect of an explosion or an impact near the surface of the land. The explosion or impact forces develop longitudinal waves which pass through underlying rock formations with differing velocities. Reflection and refraction of these waves are measured by time intervals between the explosion and the receipt of the refracted waves back to the point where they started. The measurements delineate, with some accuracy, the nature, depth and dip of the beds of the rock structures. More sophistocated methods of seismic survey have the vibrous eyes technique, and the reflection survey, the latter is used extensively and gives good depth estimations.

The purpose of the seismic search of course is to locate accurately the strategraphic traps, reservoirs which may contain oil or gas or both, and the reef accumulations of gas. The seismic survey is more rapid and less costly at sea than on land. Ice-covered waters, however, present special difficulties of electrical noise which is being studied at the moment.

We cannot pass over this subject of exploration and discovery without paying our respects to the special quality of men involved in discovery. Their work lies in the deserts and the wilderness, and there's a synthesis of discovery.

However analytical the cataloguing of results may be, here is a work of hands.

What personal motives have these men? We believe their drive is to do their very best today to improve the tomorrow and to plan for the discovery which proves that what they have done was right in all ways, and this must be the very best of all rewards to working men.

I'm afraid that all of the work and money spent in locating a drill-site simply defines a location where it is possible that an accumulation of gas might exist. Perhaps three years after the first aerial survey we might hope to reach a time of decision to drill, and a rig may be spudded in.

The gas well. Here comes a series of slides now. I think we could go through them slowly. I think that's a well in the Sahara. It looks as if it was snow but I don't think it is. This is a well in the Yukon Territory at Pointed Mountain. I think the drilling is just completed on the upper one and just about to be started on the lower one.

The first slide was in Libya, yes, it was in the Sahara all right. This is a Utah drill-site.

I should perhaps say that the drill-sites in the delta won't look at all like this. I think first of all there will be cluster drillings and these mud ponds will be in tanks. The whole thing

will be very much tidier looking. This is a rig designed to go to 20,000 feet, and is also not likely to be seen here. This is a jack-up rig at sea, probably in the Gulf of Mexico, I think, and they'll drill 12 to 16 wells right from that one point, if they intend using it as a production platform. Another deep rig, this one is in Utah, in the mountains, there's tremendous action in this picture. I must admit that all my life I've had great admiration for men who work with their hands. That's a drill crew working right on the head-works. I'm not sure if that's the same crew or not, but it possibly is. I'm afraid most of the pictures actually show drill rigs rather than wells, but a well isn't very much to show you. It's a very simple piece of piping involved.

The discovery hole must yield a great deal more than gas. Foot by foot it has to prove or modify the exploratory and seismic data in the hands of the crew, and when it reaches the designed depth and is proven a well rather than dry hole, the production levels are chosen on the basis of what exists rather than what was indicated.

Drill tests of the well may prove gas but the structure has to be delineated, and an estimate made based on the flow, the porousity of the rock and its permeability, in order to define the area and volume of sedimentary pay likely to flow to each well to establish the spacing.

The field perimeter, that is the limits of the reservoir itself, can only be defined by further drilling and in due course an estimated volume of the gas accumulation, its cost of development provides the guidelines, of a decision of feasibility of the production of the new gas field..

You have one or two more slides, there, Tom, have you?

Oh, this is a drill stem test. -- with the burning gas and condensate and with a flare turned horizontal to preserve the structure of the rig. These tests are quite brief and happen -- occur only at the time of discovery. They may involve one or two days and that is all.

This is a similar drill stem test, but taken from a floating drill rig I think in the Aegean Sea, this picture was taken, and that is just fine.

That is in Prudhoe Bay and perhaps I could -- the cost of a well is very important -- it varies with the factors of accessibility and climatic restraints and I have a number of round figures here which might illustrate to you what the costs may be expected to be. In northern British columbia, in the Yukon, and in the Delta about $4 million a well. In the Rocky Mountain foothills about $2 million a well. In the high Arctic, that is in the Panarctic groups work, about $8 million a well. In the United Kingdom North Sea, about $5 million, in the plains of Alberta

about half a million dollars a well. In Texas, U.S.A. about half a million dollars a well.

All of the work from the inception of exploration to the discovery and the installation of the well might extend from about five to seven years. And perhaps longer if a pipeline has to be approved by government and then constructed. The flow lines of the gas field. The flow lines connect the gas well to the dehydrator equipment and thence to the field gathering pipelines, the processing plant and the main transmission line. IN the provinces these works tend to have a temporary appearance because of the frequent changes that are required as well as are added, closed down or modified.

At Prudhoe Bay and presumably in the Mackenzie Valley, cluster wells, flow stations and central process plants will be designed to reduce wear and tear on the environment during the construction and operation. This cluster well concept was employed successfully in the United Kingdom NOrth Sea and in Holland, where the land won from the sea is of such importance to the people. It worked splendidly. Clusters of ten to fifteen wells drilled offset covered the production of several square miles of land with an occupational area of only a few acres.

Perhaps I could -- this is a very formal diagram of course -- these well clusters, each with about twelve to fifteen wells in them will be located where the coverage will be the

greatest and not necesarily in an orderly row like this, but they will be limited in area and the facilities for drilling one well can be used in drilling another and not repeated with a mud bath for every drill hole and from each of the clusters a single line will carry the gas to a flow station where it will be dehydrated and prepared and there may be six or seven or maybe a dozen of these well clusters and then the gas flows into the gas process plant where the liquid hydrocarbons are removed, not very much in the way of liquid hydro carbons from the analysis of the gas of the Delta and any waste liquids like brine are injected back into a safe strata below the ground.

The gas flows out of the process plant, provides local fuel gas and goes towards the pipeline.

As the gases of the Mackenzie gathering lines will be warm, it is expected that thse pipes which are shown and indicated here will be carried above the ground on supports form point to point in an orderly manner probably paralleling short service roadways. The arrays may zigzag slightly to allow for contraction and expansion as the temperatures within and outside the pipes change from time to time.

At the wellhead even gases with an analysis as sweet and dry as those given for the Mackenzie Delta contain water and water vapor. The gases also carry particulate matter from

the wellbore, chips -- rock chips, and sand and cement. These are mechanically separated from the gas immediately at the well. Water vapor is also removed as it could form hydrates of ice in combination with some of the hydrocarbons. When the gas pressure is lower then the gas expands. The temperature falls with it. This removal may be done by absorption or solution processes or by molecular sieves. The sieves may take out some of the CO_2. When the well pressure is sufficiently high an expansion refrigeration cycle will remove the water to the required dew point depression specified by the pipeline which is to support the gas.

The nitrogen and CO_2 fractions shown in the analysis before in the slide are small and possibly the pipeline will accept the nitrogen. The CO_2 is mildly corrosive and if there is also a trace of hydrogen sulfide, both can be removed in a combined treatment with an amine solution. If the gas has to be transported as a liquid, and this is contemplated at the moment for the gas being found on the Arctic Islands. If it has to be transported as a liquid it must be purified at the well head to a very high degree and all the H_2S and CO_2 has to be removed and it is then passed through molecular sieves for drying and for removal of the heavy hydrocarbons and then it is liquified by reducing its temperature down to -250°F in a series of trains of multi-refrigeration processes with the frequent recompression to

drive it through the system.

Nitrogen is easily removed in this process as it does not liquify at the temperatures used.

When the gases are liquified to L.N.G., liquified natural gas, some of the heavy hydrocarbons removed early in the process may be put back into the liquified gas to raise the calorific value of the L.N.G. to the requirements of the market. The gas is then stored in large double wall insulated tanks from which it can be loaded into the insulated carriers; ships or tank cars, or whatever you have.

The by-products removed at the processing plant are numerous and valuable. Sulphur, propane, butane, and I noticed the Arctic island gas contained an amount of helium which is extremely valuable.

The natural gas transmission pipeline. Where a gas discovery is made and the obvious market is thousands of miles away, it is inherent that the pipe be large in diameter. A small pipe or a medium sized pipe, especially costly to install, would require as operation costs such a large proportion of the final sales price that the gas discovery would be of little actual value. Roughly speaking, about 24 to 25% of the total cost of an arctic pipeline would be required each year as pipeline revenue for a feasible undertaking and the only way to keep the unit cost of transmission within practical limits and the distant transport

of great volumes is a large diameter pipe, 36, 42, 48, or 56.

The maximum through put of a pipeline, how much you can get through, is proportional to the diameter to the power of 2.5 to the operating pressure, of the nature of the gas and the profile of the route. Definition of the size of the line therefore is subject to the producable reserves established, the possibilities of further gas discoveries on the route, the costs of the damages involved per mile and the financing plan available to the pipeline company.

The designers of the pipeline, they will have a drive to validate as high a flow as possible, as large a diameter as the flow will require, as high as an operating pressure as the pipe metalogy will permit subject to the special low temperature toughness considerations of the Arctic. All of this is a complex and lengthy study, but one, which when completed, with consideration of the terrain, will help establish the probable cost of the pipeline and allow final study of the development to proceed and eventually construction to take place.

The gas will require to be raised in pressure from the first process plant exit pressure to that selected for the operation of the pipeline. This will be done at the initiating compressor station where the gas may also be cooled to a temperature below 30 degrees, to safeguard against temperature effects on the terrain. The gas pressure will be depraved by the friction of distance and by topographical losses as it travels southward, and this will require intermediate pressure restoring compressor stations originally about 130 miles apart, and perhaps as close as 40 miles apart when the pipeline is fully powered. These stations will each require 50 to 75,000 installed horsepower. In general, up to the present have been fueled by the gas in the pipeline; it may be that the economy of this almost universal practice will be re-examined in the light of the new values of natural gas, and perhaps other forms of power will be utilized.

An ideal would be a self-restoring hydro-electric power generated in the country which the pipeline traverses, but this may be too much to hope for because of the long time it takes to build hydro-electric generating equipment.

However, the liquids removed from the gas at the process plant may prove sufficient for the fuel needs of the first and perhaps the second compressor station. This, in the absence of an oil line, will present a dual advantage of useful disposal and gas economy. I should say that the biggest customer

the gas pipeline has is itself. It burns a tremendous quantity of gas to drive the gas through the pipe, and that must amount to somewhere between 5 and 7% of all the gas carried.

The other stations following the first and second may have to continue with gas as a fuel, although some liquid supply may become available on the route. I said that because you pass quite close to Fort Norman where oil is available. Any pipeline crossing the provincial or territorial boundaries, or having an international destination must be designed and constructed to the requirements of the National Energy Board of Canada which can be expected to include special environmental and socio-logical protection, design requirements specific to the project, the requirements of the C.S.A. standards, together with any special requirem ents of the province or of the territory.

A construction plan of the pipeline. The possible construction plan of the Mackenzie Valley Pipeline must contain the solution to the very large logistics problem which is involved. This solution may be assisted greatly by the general route being accessible to materials by rail, by river, and by coastal sea transport. While the construction people involved dependent for transport and sustenance will be by air , the construction force may number in total (without including services), about 5,000 people. The effect on the valley and its people must be very carefully controlled to ensure that it is temporary

minimal and hopefully, beneficial. We believe the route will be carefully divided into sections, where construction tends to be similar -- under-ground or over-ground, or by soils analysis, and that in these sections, bases will be emplaced, possibly where future administration and service centres are planned. Each base will have an air field with complete navigational aids, communications, health centres, stores, dormitoraries and work shops. They may be connected to the river by road. Double-jointing of pipe, coating or repair of coating, and principal maintenance of heavy equipment will be carried out in the section bases. Sub-bases or portable camps will reach out upstream and downstream of the base and be arranged so far as possible for all-season programs.

I don't quite know how many bases are contemplated for this pipeline, but probably four or five. When ground conditions or wildlife movements do not allow continuous year-around work, the men will be moved seasonally to sections of the route where they can help advance the project.

We believe that the regions traversed by the Mackenzie Valley Pipeline can stand the wear and tear of a wisely planned construction program. How the people of the valley will make out depends, at least in part, on the work of this Inquiry. We wish it well, as do all Canadians.

Construction may last about three years, and will be an opportunity to display the common sense, the reason and the responsibility of

the Canadian people during the great project. I have no doubt about that.

A Base load concept for a pipeline. Natural gas from the frontier, when available, is not likely to greatly increase the existing distribution systems. It may maintain the present rate of export, but should not materially increase this volume of about one trillion feet an nually. It will, of course, greatly reduce the proportion of marketed gas exported. We believe the major effects will be the replenishment of supply, and security of the future, with further use in the electrical power generation and petro-chemical production. It is very important that the great cost of the frontier developments be reflected in their efficient operation. The through-put of most existing gas pipelines vary with demand from season to season, and even from hour to hour, modified by any storage facilities near the delivery ends of the pipelines.

In the new system, Mackenzie Valley as an example, examination should be made of the possibilities of taking demand swings on the prairie producers, and holding the Arctic pipeline on base load as far as possible. This base load, for illustration, may be slightly greater than the minimum Canadian demand, plus any storage intake, plus attached export. The plan would actually employ the existing provincial production and other facilities closer to the market as a kind of a quasi storage system, providing for peaks and swings in demand and would

permit the new facility to operate at near constant rate and maximum efficiency insofar as load balance is concerned.

Mr. Commissioner, I have a film which takes about 18 or 19 minutes, showing the construction of a recent major pipeline during the winter, and this would be a suitable time to show that.

(FILM PRESENTATION)

THE COMMISSIONER: I wonder if Mr. Carter wishes to object to that film?

MR. SCOTT: No, he is reserving it for cross-examination later.

Excuse us, Dr. Bailey, carry on.

A I felt it would be a good thing to mention the operational hazards of a large pipeline at this time. Hazards exist, and in our opinion they are unlikely to seriously affect the environment or the people. Incidents in industry experience have been rare, and all have been strictly local in nature.

Hazard exists in the base centres, as in any set area of human concentration, fire is the most serious and its effect when local to the buildings involved might be heightened by the problem created for occupants under severe winter weather conditions. In the compressor stations, fire from mechanical failure again can be the most serious happening. The industry automation practice reduces the number of people on the site, and protected safety arrangements for the control room almost certainly save the staff. The fire would be extinguished by closing off the gas supply to the station and would be of very short duration, probably less than an hour. It may require that the station be by-passed, which would reduce the throughput of the pipeline until repair was made. On the pipeline itself, everything will be done to ensure the safety of the pipe; but

failure can occur, either through accidental collision of a vehicle with a pipe, or through a metallurgical fault. Pipe failure usually results in fire at the point of rupture. A fire, if it should occur, could be extinguished in two to three hours by the automatic cut-off of gas, through the drop of pressure within the pipe. It will cause total damage to the pipe involved but little else, and should not exceed one mile in length.

No cleanup will be involved, and we would expect repair to be completed and service restored within 80 hours of the incident.

The hazards of transport and travel are real enough in the north, but the procedures of the pipeline company should reduce these to a minimum level. Distribution of natural gas to consumers. I've been asked to move ahead fairly quickly. Engineering of a distribution system is fairly well standardized and is of high quality, as is the inspection service. In spite of the safety records, in spite of this the safety record has occasionally been marred by disruptive incidents which caused concern. A distributor has two special responsibilities, he is the cash register for the entire industry, payments for all gas sold excepting for export are received by him. The distributor deducts from these payments his own costs and return, and remits the balance to the transmission company who in turn pays the gas producer and gathering pipeline, retaining a balance for transmission costs. The distributor is the latest contact with the general

public. These responsibilities have been handled quietly and well and the companies involved have earned a certain community respect over the years. In Canada there are three types of distribution agencies:

- Private enterprise companies
- Crown corporations
- Community ownership.

Groups (a) and (c) are generally regulated as to prices, schedules and practice by Public Utility Commissions of the provinces. Group (b) is answerable to the Provincial administration, and of course there is a difference in access for the consumers in the two forms of regulation. Distribution appears to work fairly well. The Crown companies are more heavily staffed and therefore not quite so economical as the private enterprise companies. The future for the Canadian industry.

I've tried today to give a kind of a capsule description of the industry as it is, and I hope the gas involved has not been too aenesthetic in its effects. On the future of the industry, I have spoken to several of its leaders with the conclusion that they see about as much of the future as I do, which is not a great distance. There is uncertainty of the changing political government pressure on the private enterprise foundation. This is a reasonable state of doubt under present circumstances, and should be cleared up. The industry performance shows a healthy rate of metabolism

which indicates that greater and better directed progress can be made. In my opinion, it is essential for a national policy in gas and oil to be established as soon as possible. Who owns the gas in the reservoirs of Canada? I'd like to see it made clear that this belongs to the people of Canada, now and in the future. The administration of the resource is in the control of the provinces, and should so continue. But it must be laid down that the people of British Columbia, are Canadians living there; the people of Alberta are Canadians, even if they live in Calgary; and the citizens of Quebec are Canadians all with a vital interest in industry. Controls should therefore be limited by the obvious requirements of a reasonable treatment of the consuming provinces by the producing provinces, so that the coherence of all our people is increased. The cost of gas in any part of Canada should vary only with the cost of transmission, long or short, and of course the producing area is favored by this thought.

The gas produced, when the royalty and other provincial dues are paid, should become the real property of the producer and must commend a price giving a fair return on funds for future discovery. The present prices are too low, and an adjustment will not affect the competitive position of the product. Moreover, any property owner, including the gas producer, has responsibility and he must produce and deliver or be replaced by someone else. Such an industry has no place for capricious

handling of gas supply. Gas and oil people present an independent aspect to the public, they're not independent at all. They built up an intra-structure and depletion and other allowances and special tax treatment; this creates general distrust among many Canadians. The recent spectacle of Syncrude increases this, particularly when a pioneer company is performing reasonablly well under the present circumstances. But enough of this. Criticisms are well meant and the particulars of over-employment of limited reserves, low financial profitability of the industry's own making, poor amortization of funded debt, an d an unwillingness to put all of the costs into the gas bill, all of this is in the hope that the future will be more profitable than the past, that produceable reserves will increase, and that financial liquidity will develop and will improve. The industry is vital to our welfare and I hope for its success.

Thank you, Mr. Commissioner.

THE COMMISSIONER: Thank you very much, Mr. Bailey. The Inquiry appreciates very much your coming to share with us the benefit of your great knowledge and experience in surveying the industry for us. Thank you again, sir.

(WITNESS ASIDE)

MR. SCOTT: Mr. Commissioner, can I suggest a break of about 1 1/2 to 2 minutes when everyone who wants one goes outside and gets a cup of coffee and brings it back? I want to continue right on if we can. Is that satisfactory, that rather arbitrary

recommendation?

(PROCEEDINGS ADJOURNED FOR TWO MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. SCOTT: Mr. Commissioner, the next Commission witness in the overview is Dr. R.F. Legget.

ROBERT FERGUSON LEGGET, sworn:

THE SECRETARY: State your full name, please.

A Robert Ferguson Legget.

DIRECT EXAMINATION BY MR. SCOTT:

Q Dr. Legget, I understand that you're a graduate of the University of Liverpool and did your graduate work in engineering at that university as well.

A That is correct, sir.

Q And then you came to Canada in about 1929.

A '29, yes.

Q I understand that from 1936 until about 1947 you taught in the Engineering Faculties of the University of Toronto and at Queens.

A That is correct, sir.

Q And that in 1947 you were the founding director of the building research, I suppose a division or section of the National Research Council.

A That is correct, yes.

Q And you remained director

of that division until your retirement from the National Research Council in 1969.

A That is correct, sir.

Q I'm also told that in 1940 you made the first of a long series of visits to Northern Canada, the Arctic and the sub-Arctic.

A Correct.

Q Yes. So this territory is well known to you, is it?

A Not as well known as perhaps it might be, but I've seen most of it.

Q I understand also that from 1944 until 1969 you were the chairman of the Associate Committee on Geotechnical Research at the National Research Council.

A That is correct, sir.

Q And that in fact in 1972 you were the chairman of a pipeline conference.

A Yes.

Q Who organized that conference?

A The National Research Council, through the Associate Committee.

Q Yes. Well now, Dr. Legget, I told you not to stint yourself. Don't worry about time, we began a little late today, that's not your fault. Please car ry on as you think best.

A Well, Mr. Commissioner, I would like to start, sir, by thanking you and your staff for permitting me the privilege of meeting with

you on a Saturday morning. I'm only sorry that the hour is so late, but when I look at the task that has been assigned to me on your behalf, sir, of reviewing construction in northern Canada, if I'm to be worthy of the task that is mine, I can't do it in half an hour, but I will try to be moderate in my time, sir, and I would like to say that if there are any questions, Mr. Commissioner, that you would like to ask, or your staff, while I am proceeding, this I would welcome because I'm attempting to condense what is an immense subject into a reasonable constrictus.

What I would like to do, sir, is first of all and perhaps a little unusually, to give an historical sketch of construction as we know it in these modern days, in Northern Canada because in a very strange way that can be comprehended within my own lifetime, in 1940, for example, I saw the first machinery going in for one of the first little water power plants, and this gives a different outlook, I think, to the problems with which you are faced. Secondly, to speak in a little detail about the development of the Town of INuvik, which typifies problems and solutions of construction in the north. Thirdly, to deal very briefly with the major problems facing construction in the north, and then to deal with something that might at first sight seem to be a little unusual, but I hope to be able to show that it is part of the overall picture, and that is what I'd like to call the information problem on northern building, and then finally to make a few concluding

remarks to show how all this ties together in what is one of the most remarkable phases of construction in Canada.

In doing this, sir, I propose, subject to your agreement, to confine my remarks generally to the Western Arctic, although much of what I will say will apply to the Eastern Arctic also; not to say anything about the Yukon because the Yukon story is a different one, and it doesn't really affect directly developments in the Mackenzie Valley, and finally, as a final preliminary which I say with some embarrassment, but after discussing with others what it was thought you would like to hear, and what might assist you, I find that in making the presentation I shall be forced to talk about things that I have been personally involved in, which is against the grain, I don't normally do this, and so I beg your indulgence, Mr. Commissioner, if I mention the first person more frequently than is my want.

Starting with history, then, the remarkable thing is that it is such a very short history, because there was really nothing significant in the way of construction in Northern Canada until we come to the 1930's, which is over a relatively recent date. Until that time the only construction that took place of any significance was the erection of buildings, simple buildings, and ancillary structures by the Hudson's Bay Company, the independent traders, and the Royal Canadian Mounted Police.

This, when one first makes

such a statement, is usually questioned, but I've never yet had anyone who, after they had looked into it, find that the statement is inaccurate.

This being the case, one says, "well, what about transportation?" Transportation was very elementary, even though the Hudson's Bay Company did introduce the first steamboat on the Mackenzie River system in 1886, which goes back of course quite a long way; but this was a very simple steamboat and it was operated merely for three months to serve the small Hudson's Bay post down the river, and didn't involve any construction, and so even with this I think one can still say that until the 1930's construction was something literally unseen up here.

The first airplane flight to the north, as probably has been mentioned, and I do hope, Mr. Commissioner, I don't repeat what has been said by others earlier this week, the first flight to the north was in March, 1921. The Royal Canadian Airforce started the aerial survey work that has meant so much and has permitted the preparation of maps such as the one behind me in 1922. Imperial Oil had made their small discovery of oil at Norman Wells in 1920. They drilled the first wells in 1921, but there was no market for the oil, confirmation, I think, of lack of any activity in the north, and so the six wells that had been drilled were capped in 1924, and remained capped and unused until the '30's.

The small refinery that Imperial Oil build at Norman Wells, the one that is

familiar to many of us, was erected in 1939 when things had started, in a way that I shall mention in just a minute, and some of the oil from that small refinery was taken up to Great Bear Lake through what probably has been already mentioned, the first oil pipeline in Northern Canada, around the Bear River Rapids, which was constructed in 1939. It was 8 1/2 miles long, not much of a pipeline, but it was the first northern pipeline.

Then after that, things increased in activity, mainly because of the start of mining. Mining started on Lake Athabasca and Great Slave Lake, in the 1930's, with the discovery of gold, and on Great Bear Lake, with the discovery of uranium ore in the same period, and this is a very wonderful part of the whole story of the opening up of the north.

By 1940, that is at the end of the '30's, the mills were capable of producing 1,700 tons of ore per day. A small quantity by normal standards, but a lot for Northern Canada; the first water power plant, a very small one of 3,300 horse-power, had been erected in 1937-38, to serve the little mines on Lake Athabasca and the town of Goldfield. The second water power plant was built in the year 1940 to '41, now this is where I saw myself some of this activity, again a very small one, 4,700 horse-power, to serve the gold mines in this Yellowknife area.

The cost of the first plant, the Wellington Lake plant was$1.5 million, to generate only 3,000 horsepower and of that $1.5 million 1/6 of the total cost was the transport of the materials. I mention this figure, sir, to indicate as will become more and more evident the key place that transportation occupies in all northern questions and in particular in construction in the north.

Reviewing the situation in 1940, the town of Goldfield existed on Lake Athabasca with the population of 1,000. It disappeared within ten years and there is nothing left.

The Town of Yellowknife had a population of about 1,000, the same in 1940 and we know what it is today. El Dorado had been shut down. There was no market for the uranium ore, a strange commentary on what was to happen so shortly after, and in 1940 to date the period and the recent activity in construction, the Hudson Bay Company was still using their sternwheelers still fired with wood that was carried on board by men from wood lots on the side of the river. I saw this, I travelled on these ships.

The first diesel tugs had just been introduced a few years before to push barges instead of the sternwheelers. The Northern Transportation Company had just started because of developments in relation to El Dorado and Hay River, which we now know as such an important

transportation centre was a small Indian village and doing what does not come naturally, Mr. Commissioner, may I say that I have here a copy of a paper that I wrote in 1940 entitled "Construction North of 54" and in this I describe everything that had been done and it consisted of one small water plant, the refinery at Norman Wells andthe beginnings of a second water power plant and that was about all and I could not even mention permafrost because the name had not been invented. But we recognized the existence of perennially frozen ground.

Then, Sir, the war came and this of course changed things forever. In the first place, El Dorado was opened up, the Northern Transporation Company and the mine were taken over by the Government of Canada and we all know the results of that takeover and the reasons for it.

The most significant development though, in relation to your immediate studies, Mr. Commissioner, was the development of the CANOL pipeline. This was one of the strange developments of the war, but at the time seemed to be a rational and reasonable thing to do, because of the fact that the Japanese had over run the sources of oil in the far east and it was done with the best of intentions and with magnificent courage and enterprise, although fortunately it never really had to be used to any significant degree.

Very briefly it meant the construction of a pipeline from the Mackenzie River

opposite Norman Wells, over the mountains to Whitehorse and this was a tremendous undertaking because this area had not been surveyed, it was difficult terrain indeed and with all the complications and logistics of building a pipeline that was about 2,000 miles long -- 1,500 miles long, a telephone line and a road, but this was done in about two years. It cost, we do not know how much. The estimates vary from $150 million to $300 million. The $300 million is probably the more accurate. The pipeline itself was a four inch line first and then a six inch line, the telephone line ran the whole length as did the road.

The building of the line was carried out by American Armed Forces and it was possible because economics did not enter into it. The job had to be done and it was done, at tremendous expense of manpower and great economic drain, but in times of war this can be forgotten. It did involve though, and this is the one thing that is significant, the transfer of 60,000 tons of freight on the old system coming up from Edmonton by the Northern Alberta Railways to waterways, transfer by barge to waterways, barge from waterways to Fort Fitzgerald above the portage at Fort Smith, transfer over the portage to Fort Smith and then reshipment in barges from Fort Smith down the Mackenzie to Norman Wells and the fact that this small and very limited transportation system, with the aid of all the money that was needed and all the manpower

that was needed was able to transfer 60,000 tons in those two seasons, whereas previously 20,000 tons in one season was an outside maximum, is one of the great construction achievements of the war.

The line was abandoned, the pipe, insofar as it was possible, was removed, the buildings were used, if they could be moved and I find it significant to be standing here when our own first research station in the north was located into rather derelict CANOL buildings. They did not last very long but we did use them.

To the west during the war there was the building of the Alaska Highway which should be mentioned and the construction of the airfields on the northwest staging route. Again, great constructin achievements, but with little significant effect on the Mackenzie Valley. To the north, immediately after the war, but we can count it in the war time period, was the construction of the six joint U.S.-Canadian, or as I now prefer to say, Canadian - U.S. weather stations at Resolute Bay, Noel Bay, Alert, Isaacson, and Eureka. These were a development of the need seen during the war for much more information about Arctic weather. Their installation was a magnificent performance. Again, economics did not count and so they did not give us any significant information that can be used for peacetime purposes, but they represent a significant achievement in the north. They are

still operated,now under completely Canadian operation with U.S. participation. We do not know what they cost because the large flotilla of ships that brought in the materials was largely a naval operation, one of the greatest naval flotillas that the north has ever seen, if not indeed the greatest, but we do know that it costs today about $3 million to operate those six small stations which gives some indication of the economics of the logistics of operating stations of that kind.

The buildings themselves were simple in the extreme, naturally single storey buildings, the equipment not very elaborate, some towers but not unusual towers and so agian they did not give us very much in the way of construction experience.

Then after the war, after the weather stations were operating, other developments took place. Again, and I will put these, if I may, Sir, first, with regard to the needs for defense. ONe of the most interesting and one of the most little known was the erection of a very large steel tower for Norvan purposes, navigational purposes at Kittigazuit It was in the days when radar and radar navigation developments were accelerating rapidly and it was not necessary to use it for many years, but it was erected on perennially frozen, silty ground with all the difficulties that that involves. It performed quite satisfactorily and stood for about ten years before it was dismantled. A quite phenomenal achievement in view of the

lack of information at that time about design in the north. Much more important though were the developments of the three defense radar lines. The distant early warning line, the DEWline, the pine tree line and the mid Canada line. These too were done by the Forces of the United States and Canada at a cost that we now can be fairly certain exceeded at a cost -- that did exceed $1 billion. A remarkable sum and because they were so secret at the time and to a degree still, we have very little information about the constructional problems. Something was published about the remarkable work done in locating the sites by means of aerial photography and this was one of the first major applications of aerial photo interpretation and the sites selected were all done in this way and then checked on the ground and so far as I know have all proved satisfactory. The mid Canada line has now been phased out of operation and so the buildings stand there untouched and unsung. The other two lines are still operating, still performing faithfully their intended function, but again without too much significant contribution to the techniques and the knowledge and the information necessary for ordinary construction in the north, but they must be mentioned because they do represent such a tremendous contribution.

If I might now turn, sir, to the developments in mining. The mines at

Yellowknife although not at Goldfield were still operating at the end of the war and in 1945 the total value of the mining products in the north and I give these figures, sir, as an indication of the activity and the degree of mining, was half a million dollars. In 1955 it had risen to $25 million and in 1965 to $77 million and in 1975, this year, it might be as much as $100 million which is quite a lot of production from mines and yet to set it in perspective, this represents only about 2.5 % of the total mining production of this country, so that even though the Pine Point mine, which represents a large proportion of this total, is a very eminent mining ooperation and a very large one, it still is only a part of a much bigger operation if we look at it country wide. But what it did do, was that it fully opened up the proper development of the Pine Point mine, it led to the construction -- it with other things, led to the construction of the Grimshaw Road to Hay River and then following that the construction of the Great Slave Lake Railway by Canadian National Railways that is now operating so satisfactorally. This railway was built - - I speak of the railway rather than the road -- was built between 1962 and 1967 at a cost of about $86 million, for a length of 432 miles and it has been operating quite successfully with no problems because of the fact that its location was most carefully evaluated by those responsible. First by aerial photographs, then by using the advantage of the unusual geological features along the

way and as a result of this and I stress the matter of location and planning, Mr. COmmissioner, for reasons that will later be obvious, the reasons that have made the Great Slave lake Railway such a satisfactory and efficient operation, but it had of course another effect. It destroyed for all time the old transportation system to the western Arctic through Edmonton with NOrthern Alberta Railways to Waterways at Fort MacMurray, then the sail by barge down the Athabasca to the Portage, the use of the Portage to Fort Smith and then down to Great Slave Lake, because as we all know, now we have Hay River as a great transportation centre and I would, sir, if I might invite attention to the fact that the construction by the Northern Transportation Company of their really outstanding synchronous drydock facility at a cost of, I believe, something like $10 million has set the seal for a long time to come on Hay River as the transportation, trans-shipment point for all shipments for the western Arctic and the Mackenzie River Valley and this is perhaps, anyway the most significant construction development of which I can speak.

Taking a brief glance of at the easter Arctic, and I mention this more as a matter of interest, sir, than of value, because it is something planned but not constructed. There was in the days when transatlantic flying was all by propeller planes the urgent demand for major air base as far to the east as possible that could be used

by transAtlantic planes for refueling and a great deal of money, more than one million dollars, was spent on the planning of a great development at Frobisher Bay, a new airport, a remarkable building complex and all the ancilliary features. Fortunately it was not built -- I say fortunately because the planning I think might have been improved slightly by what we know now -- because of the advent of jet planes, and Frobisher Bay of course has been developed but in an entirely different way from what was planned in the 1950's -- one of the unwritten parts of Arctic development.

But I turn finally, sir, in this historical view, on which do hope I am not spending too long, but I hope that it will give the overall constricture, to the development of the town of Inuvik. As you know, sir, and most of those present until Inuvik was developed the main centre in the north was the town of Aklavik and a friend of mine was the man who founded the first little building that led to Aklavik being developed as a centre. It was developed as a signal station by a young lieutenant in the Royal Canadian Corps of Signals in 1922 and he has often said to me how much he regrets putting that signal station in that particular spot -- not that a settlement was not needed, but that particular spot was singularly and unfortunately chosen because it lies on a plain in the great delta that is only 11 feet above normal river level and of that 11 feet, as we discovered in our test drilling, six of the 11 feet consists of ice and 5 of the eleven feet consists

of soil and therefore when after the war, when the Government of Canada did finally -- start to look at the needs of the north and what should be done to provide the necessary facilities and Aklavik was looked at and a new school was planned for Aklavik, test drilling was carried out on the site by some of my colleagues, and we found this state of the ground. This showed that if any development took place and if any further development of the surface took place, as was necessary in any decently finished off term, that there was likelihood of serious settlement and therefore the flooding which had unfortunately affected the residents of Aklavik every year, at the time of the spring flood, would be far worse and since the needs of people then as always comes first, it was seen immediately, but because of this condition of the ground, development of Aklavik in the ordinary way just was impossible and therefore at a meeting of the advisory Committee on Northern Development of the Government of Canada, a committee that included the deputy ministers of all the interested departments, a meeting held in 1952, at which I was present, we reported the results of these investigations of sites at Aklavik, after much discussion and with the greatest concern for what was involved, that committee recommended to the Government and the Government accepted the decision that a new townsite had to be found.

A team was developed by the interested departments and the National Research Council. It did the initial study of the entire delta in Ottawa in the building of the Building Research Division by photo-interpretation methods. And in the winter, on the tables of the divisional building, twelve sites were selected as the best twelve sites in the entire area of the delta, one hundred and fifty miles by fifty miles, As soon as the spring came, the first helicopter in the North was sent north to assist the survey work. The twelve sites were studied, they were narrowed down to four. I was priviledged to go up there and study each of the four with others, and it was quite clear that one of the four was the most desirable. We then called it "East Three". And I was priviledged to be there in the summer of 1954, just before the final decision was made by the then Minister of Northern Affairs, The Honourable Jean Lasauge. He came up there to make the decision on the spot. The site was chosen for reasons that I needn't detail, because these have sir, been written up, and one of the references that I might perhaps present to your offices, is a paper that describes the selection of the site of Aklavik. It's called "The New Aklavik", the name had not then been chosen, and this describes the method that were used, the reasons for the move from Aklavik, and the reasons for the choice of Inuvik. Mainly the grading, the local geology.

Then the planning started, and I needn't go into any detail on this sir, because you know the town, and you know that because of the condition of

permafrost, all the buildings, apart from a few simple ones, had to be founded on piles, which I shall be mentioning in just a minute. The simple buildings were founded on pads, another technique. The roads were carefully laid out so that they would be well drained. There was a good supply of building material, and a reasonable anticipation of getting a good water supply, and so the town was developed, and so it is today.

And two years ago, I had the priviledge of visiting it again, and examining every building, in detail and I found not any single evidence of any failure of any sort in the foundations of that town; even though it is built on what many might regard as the most difficult ground conditions to be found anywhere in Canada. This is, I think, a testimony to the design of the consulting engineers, and the construction techniques of those who built the town.

And at the same time, of course Yellowknife was developed. But here the problems were different, with so much solid rock, which in one/way is an advantage, in another way is a disadvantage, but this was the beginning of the developments that we now know as the New North.

Well this, Mr. Commissioner, is a brief summary of construction in the North, which is, as you see, is a story really of the last thirty-five years. Against that background, might I now ask if we might consider together the major problems facing anyone who wants to build anything in the North, whether it be a pipeline or any other major construction development.

And I say any other because it has been said time and time again, that if there is a need for it, and if the economics justify it, it's possible to build anything in the North. Jokingly we have said that we would build a fifty storey skyscraper at Resolute Bay, if someone will pay for it, and then someone explain why it is needed. This is said in joke , but it has, as do many seemly facitious statements more than a grain of truth in it, because our knowledge of the North is such now that this now can be done. The question as to why it is needed, and who is going to pay for it, are the impediments. And against that, I would like therefore to ask what are the problems that can now defeat, if we know about them and if we do proper planning.

I submit sir, that there are four. First, the matter of permafrost. Secondly, the matter of the effects of climate. Third, the matter of transportation, and the economics associated with transportation. Fourthly, and perhaps in some ways the most important, the matter of manpower.

Now I understand Mr. Commissioner, you have a briefing with regard to permafrost from my friend Dr. Ross McKay, so I will start, if I may, knowing him as I do, where I think he probably left off. As you know, and as he stressed sir, permafrost is not a material, despite all the things that are said about it. It is a condition of the ground. The condition of the ground wherein it is perennially frozen to some appreciable depths, because of the local average air temperature. This being the case, if ground is solid rock, there is no real

problem. That is why, at Yellowknife for example, building is no problem from the point of view of permafrost. If however, the ground consists of water bearing soil, silt clay or even fine sand, the water will be ice and if you interfere with that, then you are going to have problems, and therefore you must somehow preserve the condition of the ground if your building is to be successful.

If there were time sir, to quote from ancient references we could give you many references, of early settlers in the North, notably from the Hudson Bay Company who discovered this to their cost. There are many small buildings that show what will happen if you don't know what you are doing, and if you don't preserve the integrity of the ground.

Against that background, let me suggest that in design, when you have to design structures in the North, there are three ways of protecting the ground in its frozen condition. Either, in the first place, you isolate your structure completely by putting them on piles, as has been done at Inuvik. That's the best of all examples. The utilidors, the buildings, the schools, as you know are all above the ground, so that the air in wintertime can flow underneath them, and keep the ground in it's frozen condition, and in this way preserve the integrity of the permafrost, And as is obvious to anyone, this has worked entirely satisfactorily, despite the extra cost involved, but there is no problem as a result of any undue settlement or interference with the ground. A second way, is to, if you have to interfere with the ground, to install a refrigerating plant and freeze the

ground after you have thawed it. This sounds rather stupid, but there are some cases where this is the only solution. Fortunately, through design and good fortune we have not had to use this solution in Canada yet. There is however, a power station in Alaska, that is maintained in its position by refrigeration of the ground beneath it. A very costly way of doing it, but it can be done. The third way is the simple way. Of calculating, as one can, what depths of fill, preferably a porous fill, like sand and gravel or crushed rock, what depth of fill you need above the natural ground, preserving it by suitable means, such as placing brush over it, what depths you need to prevent the heat from the building that you are going to put on top of the slab reaching through the thickness of your pad of granuline material into the ground. If you make the depth thick enough, then the heat will be dissipated before it reaches the ground. I trust I am explaining this in reasonable terms sir, because it is a matter of heat transfer. And it is possible, by very straightforward methods, to calculate the depth of sand that you need above any permafrost condition, if you know what it is. To be certain that the heat from the building you erect above will not reach the ground and therefore the permafrost will be preserved. And the best of all examples is the airstrip at Inuvik.

Here was a demand for the building of an airstrip, to carry the largest planes available on the worst possible condition, because it was unusually high water-bearing silt upon which that airstrip had to be built, because of location requirements,

and therefore, before work started the ground was studied The permafrost was investigated carefully, the ground above, the muskeg cover was not interferred with at all, and we were then able to calculate the necessary depths of crushed rock in that case, that would be needed upon which the airstrip could be founded. When the calculations were done, it was checked independently by one of our friends in the United States geological survey, who agreed with the figures, and the airstrip was designed on that basis. In order to do the necessary and desirable research, as it was being built, recording thermo couples were imbedded in the fill and they have been observed and read regularly from that time to this. I checked on the results just before coming away to this meeting sir, and I am assured the airstrip is still performing exactly as it had been planned, despite the fact that you have there a black surface that absorbs solar radiation. And therefore have one of the very worst possible conditions for thawing the permafrost condition, unless you have taken precautions.

The precautions were taken, actually the permafrost has risen slightly, rather than degrading, and the strip is performing and has a surface today that is the equal of any airstrip anywhere in Canada. Despite its location, so it can be done, and this is the reason that I mentioned this particular case.

Turning to the difficulties in construction presented by permafrost, these are very easily stated, because they fit with what has to be done in design. If you are on ground that consists of the

frozen water bearing silt, this is going to be kept in its condition in practically every case, by the protective cover of muskeg, to use the delightful Indian name I like but other scientists don't, they call it peatland, but may I say in your presence, we use the term "muskeg", because then we all know what we are talking about.

The muskeg, mainly because of its high moisture content, it's like a great sponge, acts as a perfect insulator for the material underneath. And, as I am sure that everyone who knows the North, has seen, this is fine, providing you don't disturb it. If you disturb it by running just one run of a bulldozer over it, you will compress it, you will squeeze the water out, you will interfere with its insulating effect and when you come back next year, those ruts will be deeper, because the solar radiation has had a chance to operate, and you have ruined something that can never be replaced. And therfore the one key in construction which is absolutely manditory, is that nothing must disturb the muskeg cover, if you are anxious to preserve it for your design purposes.

Perhaps, I might just use one minute to give a rather graphic example. When the small road was being built from Uranium City to the little port of Bessell on the north shore of Lake Athabasca, the foreman in charge of the road building was an old man who knew the North, who knew muskeg, and who knew exactly what to do. He didn't let his men even walk on the muskeg before they cut the brush down and covered it with brush, and they walked on the brush. The sand and

gravel for that road was placed on the brush, and a good road was obtained. He went away on a two weeks holiday. While he was away, his assistant took over, His assistant was a younger man, who knew everything, and knew that the old man was just being silly, and so proceeded to bring a bulldozer in and tore the muskeg off. If you ever, Mr. Commissioner, drive along that road, may I suggest with great respect, that about halfway along, on the northern side you will see an area that looks as though it had been a volcano. This is the silt that was disturbed by that two weeks operation of the bulldozer and it took five years before it came to a stable condition. The road had to be changed. So this is a perfectly simple perfectly straightforward , but very difficult requirement in construction. And it is difficult because it affects access.

These sir, are the ways in which permafrost, once you know it, can be dealt with, in design and construction. But my qualifying words are, or course, vital. The primary requirement is that you must, if I may presume to use such a word sir, emphatically, you must know what site conditions are in detail before any work is planned and certainly before any construction work is carried out. And in order to do this, you must therefore know what the structural function is of the structure that's to be erected. If there is to be any heat loss from it then the necessary calculations must be done in advance.

R.F. Legget
In Chief

This is the special sort of planning that must be done before any construction, be it small or great, is carried out once the southern limit of permafrost is passed.

Now comes the second problem and that's the effect of climate. This we can deal with fairly easily because it's fairly straightforward. You will know, Mr. Commissioner, from what others have said, that it's not the intensity of the cold in the winter that is the serious problem, it's the duration of the cold. The further north one goes, the greater the number of degree days, the greater the length of the winter season, the greater the problems of winter construction, and these are problems with which Canada and the Canadian construction industry is fully familiar. Perhaps it's not out of order for me to say that when it comes to winter construction methods, Canada leads the world. There is no doubt about this, people come from many countries to see how we carry out construction in the winter in Southern Canada, the methods in the north are just the same except that they have to be used for longer periods.

The most serious one is the necessity for lighting during the winter months on a scale that is not known in the south; but again this is an easy problem to deal with, provided you know it in advance; and this again points to planning. Here perhaps is the point at which I should apologize for having to use the word "planning" so often, but by the time we finish our review you will see that it

is this, it is the key to construction in the north.

The Mackenzie River flood, which in some cases as is well know, lifts the level of the river as much as 60 feet, if you're working near the river, has to be known in advance and has to be planned for, but this is know. In earlier days we did not know very much about the climate of the north but through the activities at the six Arctic weather stations, we now have a very clear and a very good picture of climate throughout the north of Canada and on the basis of a number of years, statistically enough can be reasonably certain to predict what climatic conditions are going to be. The information therefore is available. If the planning is done, I submit, sir, the climate is not the problem that most people think it is.

Turning then to the third, transportation, the big jobs that I mentioned earlier and one of my reasons for mentioning it was to emphasize this point, such as Canol, the Dew Line and the weather stations, were all carried out without regard to normal economics. If you have enough money and enough men and the need, as I have said earlier, you can do anything you wish in the north. But when we come to normal construction, then we have to consider normal economics, and this means that transportation of any construction materials and construction equipment will have to go by land or water. Fortunately, we have in the Mackenzie River system one of the world's greatest water transportation systems. Unfortunately,

available for only three months of the year, but are showing what can be done now that Hay River can be the trans-shipment point. Perhaps it has not yet been mentioned that in 1973 the Northern Transportation Company carried as much as 400,000 tons down the river. That's a phenomenal achievement and I've been advised that they anticipate that with the necessary equipment they should be able to reach 600,000 tons in one season. If you compare that with what I said earlier about 20,000 tons being a maximum for the old system, you will see what advances have been made.

But even that may not be enough for major jobs, and I'm speaking naturally in general terms for now, and here is where winter roads come in, and here perhaps I should stress that while recently some of us have been delighted to read a very enlightening and lively account of winter road construction, perhaps, Mr. Commissioner, you too have seen it, this of course was on a very modest scale carried out by wonderful people, to whom we must all pay tribute; but if winter roads have to be used on a major scale, then its going to be an entirely different operation, in that these roads will have to be made, that is to say by preparing proper ice formations where the ice is weak, by proper grading in advance of winter conditions, and if this is done, our knowledge of ice as a material has been studied now in building this and snow as a material, and the ways of handling them are such that it should be possible, with planning, to prepare winter roads capable of carrying the heaviest

needed loads for any sort of construction for an appreciable period, and if one therefore couples the use of designed and specially constructed winter roads with the potential of the Mackenzie River system. We have a tremendously powerful system for transporting the heaviest loads throughout the entire valley, and this is one of the good features of the problems that I'm describing.

But again, and here I must mention the word again, this means advanced planning, because the Northern Transportation usually finds themselves booked solid before they start to move a ton from Hay River, and winter roads, as I've just indicated, can't just for the purposes of major operation, be done with no planning. They must be planned at least a year ahead, and for transport requirements on a major scale, allowing for the facilities that do exist, wonderful as they are, at least two years of advanced planning must be done. This, Mr. Commissioner, is probably the major difference, apart from permafrost, between construction in Northern Canada and construction elsewhere. The methods are similar, the equipment is similar, the materials are similar, but to have to plan two years in advance is something that in the south where one can immediately go to a store and buy something, if you haven't got it; these are the big differences, and why planning on a major scale has always to be done for any construction operation, even the smallest, and why a time scale for construction in the north is so different to what it has to be and can be in the

south.

The final problem, I venture to suggest is that of manpower. I'm quite sure there's little need for me to go into it in any detail except from a construction point of view, because others who have preceded me have talked about the northern people, their needs, their simply marvellous capabilities, when it comes to construction operation, capabilities that make us people from the south look like tender-feet. This, I pay due tribute to, having seen their skills in operation. But we must remember that their numbers are limited. The numbers of able bodied men are limited in the north, and many of them have already jobs doing excellent and vital work in the north. So that the number of northerners available for any major construction operation is limited. This means that men will have to be brought in from outside, there are all the problems that that means, and again this means planning.

I mention this problem, sir, merely to indicate that I recognize it, even though as I say I'm quite sure it's been dealt with.

These then, sir, are the problems, not insuperable, problems that can be recognized, if they are recognized and if I might repeat this one thing, if proper site investigation is always carried out well in advance of design, well in advance of construction, anything is possible in construction in the north.

But the planning requires

information and knowledge, so may I turn to the other major aspect of this overall subject that I would like to place before you?

This is the nub of the information problem. Here, sir, is where I speak with unusual diffidence, and you'll see why in just a minute. As I've indicated from what I've said already, the information is available for building anything in the north -- climatic information, permafrost information, investigation information, you name it, it'S available if you know where to go, an d if you go and get it. But unfortunately, all too often when we hear of problems in the north, they are problems created by people who don't know that the information is available or if they do, they didn't go to get it, and I have myself seen to my intense regret, so many examples in the north of what I would venture to call, with great respect, Mr. Commissioner, re-discovering the wheel, that I felt it was desirable that I should ask if I might use a little of your time to stress the importance of it.

I do so because the National Research Council, as the war came to an end, recognized that construction throughout Canada, once that awful war was over, would be something quite different from what Canada had ever seen before, and so in 1946, before the war actually was officially over, they had considered this and decided that the time had come when they should set up a national construction research organization, to aid the construction industry which, as you will know is by far Canada's largest industry,

As this industry grew to an extent that even then could not be foreseen and faced problems that never before had been met, and so it was that in 1947 the Division of Building Research of the National Research Council was established, and I was privileged, for reasons that I can never really understand to ask if I would leave teaching at the University of Toronto and go to Ottawa and start something that didn't exist. I talked to people, amongst others, the chairman of the then Defence Research Board, as we groped our way in the early days trying to decide what we should do from the thousand and one things people expected us to do. There was far too much for any one organization to do, so we selected the five major branches of building that were peculiar to Canada, one of which was building in the north, and this was in 1949. We started our work on studying the problems in the north in 1950. At the time we were regarded as rather unusual people -- I'm choosing my words there, the words used in description were not quite so polite, but some of us had the vision that the day would come when knowledge of the north would be necessary, and so our first effort was to get a young man, a young research officer, and he booked -- engaged a boat at Hay River and went down the Mackenzie River and studied every building that existed in the Mackenzie Valley from Great Slave Lake to the Arctic, examined each one, examined the problems in practically every building in those days, if my northern friends will forgive me, every building had some problem, and then listed them, put it into a report,

and this was known as the Dooms Day Book of the Arctic -- of the Mackenzie; but from that book we looked at the problems, we looked at what had happened, and from that charted the course that research in the north should take.

The next thing was to establish a station so that we could study building in the north. This was established in Norman Wells, first in the Canol Buildings, later in two pre-fabricated buildings which will be known to some, but then we found out that the real problems in the north were not in the Arctic region where you have permafrost to great depths, but in the southern regions where permafrost gradually faded out, and that is why we were so concerned with the limits of permafrost and why we moved the station from Norman Wells to work out of Aklavik in the northern part -- Aklavik and Inuvik for the northern problems, and to deal with the southern problems by coming up to them from the south

and for 13 years one research officer spent every summer on this work with regard to the boundary of permafrost, mainly using helicopter, and from the basis of that, the permafrost map that I believe Dr. McKay introduced to you, was produced. This is just a map but it carried with it not just what normal maps do, it represents the accumulation of those 13 years of intense hard work in the north. Perhaps if Dr. McKay did not mention it, I might invite your attention, sir, to the fact that the map was published jointly by the Geological Survey of Canada and the

National Research Council, as an indication of the way in which people can work together, an d not in watertight compartments, as is sometimes believed to be the case.

This map was produced in 1967 before we knew that we would ever face such exciting prospects as those with which the Royal Commission is dealing, and we were fortunate to have it. We had no second sight , sir, I don't want to suggest that for one minute, but it was prepared in preparation for the day when Canada might need it. In addition to that, work was going on with regard to problems. We used the Town of Inuvik, naturally, to good effect, because some of the installations there were experimental. When necessary, instrumentation was installed so that we could see how designs worked out in practice. These are still continuing, and all this work has been written up, and there is available for those who want to read it now, a series of papers dealing with practically every aspect of building in the north from both the design and construction point of view.

Amongst the documents that was produced was the Building Code for the North. This is dated 1968. This is a special pocket edition made in pocket size so that anyone in the north could slip it into their parka, based on the National Building Code of Canada, which is used throughout the rest of Canada, but with a special section on the requirements that must be taken, in general terms, when building anything in the north. I only regret to

say that not too many copies of it have been used, even though it's been well-publicized. But here it is. It is in the process of revision and it was the first such document to be prepared in English. It was based, and we have the Soviet document that corresponds to it, and I'll be speaking of the Soviet work shortly.

The next thing that I would have liked to have been able to produce at this hearing I can't because of the only real disappointment that I suffered in this work, and that was we had seen the need once the more recent developments had started, for a manual that brought together all information on construction in the north, both design and construction. We planned an outline and started the work on a manual for northern or permafrost engineering, but I regret to say that the National Research Council has not been blessed with the funds necessary for such operation, and that work had to stop because of lack of money and manpower. It has now been taken up again, again with very limited manpower and very limited funds. I say this not in any criticism of our government, but in explanation as to why it isn't here. If all goes well, such a manual will be available in the fall of this year, but much later than it should have been.

But the information is there in other forms, and it has been disseminated in a way that is again not well recognized because the National Research Council has always taken the view that while

it does research that is needed in such bodies as the Division of Building Research, it wants to stimulate research anywhere else in Canada by those who can do it, and therefore as all of us know, one part of its program has been a granting program to stimulate and encourage research at universities. Not only that, but under the guidance of the Right Honourable C.D. Howe, as one of his great but minor contributions to this country he started an active program of what are known as Associate Committees. Now as soon as I mention the word "committees" in some people's hearing they react straight away and say, "Well, what, another bunch of committees?"

But this is a very special bunch of committees. Because of the size of our country it is not possible normally for those with common interests living in Vancouver and Halifax to meet and share their problems and share their experience, and so ever since the war when this technique was used to great advantage, the Research Council has set up a number of Associate Committees, not too many, the members of which are drawn from coast to coast from every discipline in one particular field of national concern, and the Research Council pays expenses only. The time is given voluntarily, and in this way in a quite remarkable manner it is possible at any one time to get the national consensus on any major branch of science in this country. One of these committees is the Associate Committee that was mentioned to you earlier, the Associate Committee is now called

geo-technical research. It was set up as a special wartime effort in 1946, but after the war it transformed its work to civilian work and in 1948 organized four sub-committees on soil mechanics, snow mechanics, snow and ice mechanics, muskeg and permafrost research, and this Permafrost Research Committee has been in existence since about 1950, bringing together anyone who is interested in Canada, and expert in permafrost and permafrost research for a sharing and pooling of information, for the sharing of problems, and for the stimulation of research, and one of the ways to do this is to call a meeting and ask anyone who is interested to come, and the first such Permafrost Research Conference in Canada was held in 1958. There have been held since then seven conferences. I have a list which I can leave, sir, for the record, going on to 1974. These have been most stimulating. People come to those meetings, with other men and women who are concerned with permafrost problems, and it is in this way that across this country there is a small group of people who know what permafrost is, know what the problems are, know where the information is. One of the productions of this committee quite recently has been a document that has not yet, I think, been released, on permafrost terminology, and you can appreciate, I'm sure, Mr. Commissioner, how it is essential that those of us who talk about permafrost should use the same words in the same way, and that our Russian friends with whom we keep in such close touch, should know the English equivalents of

what they're talking about. So this has been produced, again I will leave this for the Committee papers.

Then not only on the national scene but on the international scene from the very early days this same group have been in touch with those in the United States concerned with permafrost, notably because of Alaska, and particularly in the Soviet Union, who together in talks with our friends in the Soviet Union and the United States it was agreed that in the early '60's, the time had come for an international conference, not a social event at all, a hard-working conference on permafrost problems and solutions. We naturally were expected to host this conference, but we were too busy with such a limited staff, I only had five colleagues working on northern problems, and I'd been told to reduce that number but I put the telescope to my blind eye and didn't do it, but we just had five, we were so busy that we couldn't organize the conference so we asked our friends in the States if they would do it. They organized the first conference at Perdue University in 1970 -- 1963, and with some deference sir, I think I should mention this, that the two opening statements of that conference were made by my good friend, Professor Tsytovich, the chairman of the Russian National Committee on Permafrost, and myself as the chairman of the Canadian National Committee on Permafrost, talking together and sharing our experiences, in the United States.

I think this is an indication of what international co-operation has done.

The second international conference was held in the Soviet Union in 1973; the third one hopefully will be held in Canada , and the planning for this is now being done and we hope that we will have the necessary manpower. This will give you in brief space, sir, the overall picture that there is a great deal of information in Canada, and one of our delights has been to see at each of the Permafrost Conferences a very large attendance of our friends from the United States. They do excellent work in Alaska, we're in touch with that and share, naturally, all the information that we've got with all the information that they've got. But perhaps it will be more surprising to know that exactly the same thing holds true with regard to the Soviet Union, and I'm not speaking now of the official delegations that go officially, and the official agreements. I'm talking of personal friendships and personal visits.

I mentioned Professor Tsytovich, who has been a personal friend of mine for 20 years, and he sends me copies of all his publications directly from his desk to mine; and I send mine, such as they are, to him. But more than that, sir, we have had the two top permafrost experts from the Soviet Union, Professor Vyalor and Professor Melnikof, here in Canada for two months as our guests, and we took them everywhere. They have been to Inuvik, they looked at Inuvik with pleasure, they

said, "That's fine, that's just what we do except that we don't put up such elaborate and such expensive buildings. How do you get the money for that?"

Questions like that. Correspondingly, m y colleagues and friends, Dr. Brown and Mr. Johnston, spent three months in Siberia by request, and they, too, were shown practically everything. We know what they weren't shown and we know why not, and they were given the most complete and detailed information of everything the Soviet is doing, and perhaps to epitomize it, we once had a visit from the Director of Construction from Krasnoyask, which is one of the cities in the middle of Siberia, it was when other colleagues were away and so I had the privilege of talking with him through an interpreter, we spent a day together, each of us listed the problems that we met with in northern building. Each of us then listed the solutions, alternating, and at the end of the day our problems were identical and our solutions were identical. I do want to stress this because there is so much misunderstanding. One reads that the Russians do this, why can't we? The reason for the further development in the Soviet Union, as I'm sure, Mr. Commissioner, you will be well aware, is that they have industrial mineral developments and rare mineral developments in Siberia that we don't have or have not yet discovered. They have, for example, the biggest diamond mine in the world, far more valuable than South Africa. They have gold mines. They have coal in a way that no other

part of the world has got, and it's for these things that they have developed towns and buildings in the north which we could build just as easily if there was the need for them; but their view about the northern development is the same as ours. They do this, they build these developments, they carry out these constructions only when there is the economic imperative for it.

We have this, as their solemn assurance. So this is the situation with regard to the Soviet Union, Canada and United States.

To finish with one perhaps interesting detail, we thought that one of our duties in passing the information on would be to prepare a film on northern building, and we got the National Film Board to do this. It was prepared about ten years ago, and it's called,

"Building in the North."

I think perhaps I should say that I was criticized severely for wasting public money on such a film. It is a good film, I think, and today, ten years later, we have six copies and I have told Mr. Morgan, sir, that I would bring one with me in case you might have the time and the wish to see it.

To my amazement, sir, all six copies are out on circulation to universities in Canada and have been all winter, and so I shall have to use special prerogative to get a copy, but I will do this, Mr. Commissioner, if I may, in the hope that perhaps you might see it. It's only 15 minutes.

It's in color. There are cartoons. There is one mistake in it -- oh, the cartoons are not the usual sort. The cartoon message of indicating what permafrost design is, I should hasten to qualify. It's an entirely respectable film. It's dated, sir, by showing a steam locomotive rather than a diesel locomotive, so you know the date on which it was made.

Now, the reason I mention this is not only to indicate that a copy is available, but one copy is in Moscow and their copy is practically worn out and a copy of their film is in Ottawa. They have a film, but theirs is in balck and white, ours is in colour -- theirs is half an our, ours is 15 minutes. Apart from those two things if you saw the two films as I have several times, you would swear that they were made by the same man. As proof positive that there is no significant difference in technique or knowledge there is in economics, there is in materials. They use concrete where we use wood. They put up big buildings because of their mining. We put up smaller buildings at present. So their information is available to us. We have in Ottawa a copy of their building code, of all their major northern publications, most of them are now translated, they have ours.

Finally, sir, perhaps I should mention that the pipeline conference, when the pipeline activity in the north became active in recent years, the associate committee/under another chairman, went to the pipeline and gas and oil industries and said would it not be a good idea to sit down together and share the problems and see if the National Research Council is doing what it should be doing.

now

So a pipeline subcommittee was appointed with the full co-operation and hearty co-operation of industry in a way that is such a delight for anybody in the National REsearch Council

to experience. It is always the way when the proper approach is made.

This subcommittee saw the need when the time was ripe for asking if the companies that had been doing the research in the north preparatory to the preparation of the pipeline submissions would be willing to say in public what they had been doing. We were told that this would be done and so the first presentations of research work preparatory to the pipeline submissions were given at the pipeline conference, the proceedings for which, sir, are here, you know them I am sure.

This was a meeting that we planned with diffidence as one always does. We thought if we got 300 we would be lucky. We had 600 and when I say that we had an audience of 500 to the last minute of the last session, you will realize that it was a significant meeting in more ways than one and this book contains the first statements of the research work which I do hope will be of assistance in the further developments of the studies now being made.

One delight was that six of the 600 came from the Soviet Union headed by the deputy minister for the oil industry who came over specially with his senior aides. I had a delightful talk with him and he told me, through an interpreter, because unfortunately I do not speak Russian and he did not speak Canadian, that he told me that he had to come to Ottawa to find out what they had been doing

because his colleagues had got together a paper which they gave us telling what they had been doing, but he said that the entire trip had been more than worth-while for what he had learned about what we were doing and so here agian is the same thing.

Then after that there has been mentioned to you already, sir, another meeting, but I thought that I should mention it to. The one at Mount Gabriel, the proceedings for which are in this elegant blue book. THis is "Science of the North" and again, the six basic papers in this book and the discussions I trust may be helpful but they do indicate the widespread interest and the acceptance of problems in the north but with the acknowledgment that the problems can be met if people will go for the information, and this, sir, I will if you will permit me, make my one repetition, because so much work has been carried out in the north by those with the best of intentions, with expert technical skills in building, in civil engineering, in construction and architecture who just did not take the final step in asking what other people knew of the area in which they were going to build. There is for example an example far from here of a new town plan that was developed, a beautiful plan, and today is a splendid town, but it happened ot be on the southern limit of permafrost and the designers did not know that. If they had put a telephone call through to Ottawa, the location could have been spotted on an aerial photograph, so for the cost of perhaps $3.00

they could have found they were on the edge of perma-frost, but they did not.

There have been construction operations in the far north carried out by people who were expert construction men in the south of CAanda who thought that in the north they could apply the same methods, but you cannot, and so with your permi-ssion, Mr. Commissioner, I would like to quote just one thing from the Mount Gabriel seminar.

There was a working group there considering the paper on technology consisting of really perhaps the most expert group that one could select from the whole of Canada of those who know the north, who know the problems and who know what must be done and their unanimous decision was that they would recommend this: "that the group urges that prequalification of all designers of publically financed buildings and structures for the far north and of all contractors for publically financed northern work be mandatory." In other words, that no designs and no construction be carried out for the north of CAnada except by those who know and can prove that they know what the problems are and that they know where the information is and if that requirement had been in vogue earlier, such problems as have arisen and have created unfortunately in some places and in some cases wrong impressions about building in the north, these could have been avoided and this points finally, Mr. COmmissioner, to the need for making sure that this does not happen

in the future and this means training, and here we are up against a difficulty because there are problems in the rest of Canada that require more than the manpower we have available and so the manpower available for the special technical work of the north is limited, but there is, and it is a privilege to say this, training on northern problems now being given to engineers at Universities of Alberta, the University of Waterloo and Ecole Politique in Montreal. There may be others and if there are, and I'm omitting them I apologise, but to my knowledge, these are the three where regular instruction as an introduction only to northern problems is given to undergraduate engineers, but this of course is just a beginning and because of the needs and because of the eminent desirability of this prequalification which means pretraining being made mandatory as I hope to see, there will be the need for training on a scale that has not perhaps yet been fully realized for any of the great construction that is to be carried out in northern Canada, if and when that takes place, and this -- and I speak particularly with regard to engineering, because the engineers in their normal training do not get the necessary information. It is there, they have to be introduced to sources, they have to be introduced to the need for any information that they gain in the ~~north~~ being put into the common pile for the common good, and this is a training program that cannot be hurriedly done.

Now, it is not for me,

Mr. Commissioner, to say perhaps more than that, except that this is not a matter of planning a short few days course that can be arranged quickly.. I visualize something much more important than that for any major construction operation, and when I say that of course one thinks of a possible pipeline that is to be built in the north.

Correspondingly with regard to training construction workers, here to is a problem. Because skilled workers are going to be needed. There will be few northerners available from other jobs to do this and so my hope is that we shall see, if I may presume, with your permission to voice just one or two opinions in conclusion.

I hope that we shall see a our northern fellow Canadians trained not so much in the construction techniques, but in the operation of such facilities as are built, such as pipelines, if they are built, so that they can continue to operate them after the construction crews have disappeared; and I say that because, again, and I am now drawing all that I have said, sir, to a conclusion, and I speak now as an engineer, because my picture -- as an engineer of the future of the north, is the pipeline perhaps, if it is so decided by yourself, sir, by the Government of Canada, for gas and possibly for oil, to utilize the resources that nature has given us, the development of mines, further mines, and the necessary rail facilities, necessary to supplement the Mackenzie system when they are discovered, but beyond that I

see the future of the north as the Government of Canada itself has stated in its second major guideline: the conservation and enhancement of the natural environment and may I stress that it is an engineer that is saying this because my view of the north is we must protect it.For reasons that I hope that I have made clear it is one of the most fragile environments in the entire world. The environment can be utilized for public good and for commercial purposes with proper planning. Planning on a scale that this country has probably lnever seen, with the greatest care by manpower properly trained and properly skilled, affecting only a minute fraction of one degree of the total vast area that constitutes this marvelous, most marvelous of all natural areas in the world and I want as a Canadian and as an engineer and as a lover of the North to see it so preserved, consistent with the pubic good.

Sir, Ithank you very much for your hearing. If I can answer any questions, I am at your service.

THE COMMISSIONER: Thank you very much, Dr. Legget. We are gratefully in your debt for coming here as one of Canada's great authorities in this field and giving us the benefit of your enormous knowledge and experience. I think that I will turn to Mr. Scott for further guidance at this point.

(WITNESS ASIDE)

MR. SCOTT: Mr. Commissioner, I am going to ask Mr. Morgan if he will review the

material to which Dr. Legget referred, he had some of it, I just want to ascertain that we have all of it, whether we have absorbed it is a question that will begin to appear later in the Inquiry.

THE COMMISSIONER: I must say, Mr. Scott, that I should like Dr. Legget's paper on northern construction prepared in 1940 to be marked as an exhibit, the paper relating to the plan for the new Aklavik, the permafrost map which Dr. McKay showed us in slide form, but just in case it was not the same one, the building code for the north, the committee meetings and the film. We already have, Dr. Legget, read and felt to absorb the material and the publications relating -- coming out of the pipeline conference and of course in science of the north and we will be rereading that material as we go along. I think I should also say, Mr. Scott, that since Dr. Legget is the last overview witness, the Inquiry intends -- that is, as a gesture of appreciation to those who gave evidence on the overview to present them with the volumes of overview evidence and the slides when they have been completed in a form that will be suitable and I think that I should say that the Inquiry appreciates the help that all of the overview witnesses have given to us.

MR. SCOTT: I take it, Mr. Commissioner, that our general object will be to mark the appropriate documents on Monday when it will be marked with some others with exhibit numbers -- or Tuesday, rather, and generally to assure that

Dr. Legget goes back to Ottawa empty handed, where possible.

May I suggest,sir,that we should,-- this being the last overview witness -- that we should adjourn until Tuesday at nine o'clock.

THE COMMISSIONER: Tuesday at nine o'clock.

(PROCEEDINGS ADJOURNED UNTIL MARCH 11, 1975)

MACKENZIE VALLEY PIPELINE INQUIRY

IN THE MATTER OF AN APPLICATION BY CANADIAN ARCTIC GAS PIPELINE LIMITED FOR A RIGHT-OF-WAY THAT MIGHT BE GRANTED ACROSS CROWN LANDS WITHIN THE YUKON TERRITORY AND THE NORTHWEST TERRITORIES FOR THE PURPOSE OF THE PROPOSED MACKENZIE VALLEY PIPELINE

and

IN THE MATTER OF THE SOCIAL, ENVIRONMENTAL AND ECONOMIC IMPACT REGIONALLY OF THE CONSTRUCTION, OPERATION AND SUBSEQUENT ABANDONMENT OF THE ABOVE PROPOSED PIPELINE.

(Before the Honourable Mr. Justice Berger, Commissioner)

Yellowknife, N.W.T.

March 11, 1975.

PROCEEDINGS AT INQUIRY

VOLUME XV

ALLWEST REPORTING LTD.,
4299 CANADA WAY,
BURNABY 2, B.C.

APPEARANCES:

Mr. Ian G. Scott, Q.C. Mr. Stephen T. Goudge, Mr. Alick Ryder and Mr. Ian Roland	for Mackenzie Valley Pipeline Enquiry;
Mr. Pierre Genest, Q.C. Mr. Jack Marshall, Mr. Darryl Carter, and Mr. John Steeves	for Canadian Arctic Gas Pipeline Limited;
Mr. Reginald Gibbs Q.C. Mr. Alan Hollingworth	for Foothills Pipelines Ltd.;
Mr. Russell Anthony, Prof. Alastair Lucas & Dr. Andrew Thompson	for Canadian Arctic Resources Committee;
Mr. Glen W. Bell and Mr. Gerry Sutton	for Northwest Territories Indian Brotherhood and Metis Association of the Northwest Territories;
Mr. John U. Bayly	for Inuit Tapirisat of Canada and the Committee for Original Peoples' Entitlement;
Mr. Ron Veale and Mr. Allan Luke	for Yukon Native Brotherhood;
Mr. Carson H. Templeton	for Environment Protection Board;
Mr. David Reesor	for Northwest Territories Association of Municipalities
Mr. Murray Sigler	Northwest Territories Chamber of Commerce

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Yellowknife, N.W.T.

March 11, 1975.

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. SCOTT: I have no more overview witnesses, Mr. Commissioner.

I felt at opening this morning I had an obligation, in view of my undertaking to you to report to you and the other participants about Commission counsel's meeting with the officials of the Department of the Environment in Edmonton, which arose, of course, out of the conversation and correspondence with the Minister, which has already been referred to in the evidence.

On Sunday last, March 9th, Mr. Goudge, Dr. Fyles and I met in Edmonton with representatives of the Department of the Environment, including John Tenor, the Assistant Deputy Minister of the Department, and Charles Alexander, counsel for the Department, and a number of other senior officials The purpose of this meeting, of course, was to discuss ways by which the offer of co-operation to the Inquiry and its participants that the Minister had made last week could be effected expeditiously. The discussion and its resolution can really be dealt with under about six headings.

In the first place, the Department of the Environm ent confirmed for us that in compliance with your ruling, the list of Department of Environment reports and studies which had been filed by the Government of Canada through me, included

on it all unpublished reports or studies that were relevant and that had been prepared by or for the Department of the Environment. So first of all, we obtained an assurance from senior officials of the Department that insofar as unpublished reports and studies were concerned, the list was complete.

The second major matter considered was that the Department of the Environment in preparing its list of reports and studies had concluded -- I think not unnaturally -- that the purpose of that requirement of the Inquiry was to assure that complete disclosure should be made of reports and studies to all participants. They had not, therefore, and were not able to assure us that the list filed, set out all published reports and studies, and the officials of the Department indicated --

THE COMMISSIONER: Excuse me, Mr. Scott; Mr. Waddell, leave that door open, this is a public hearing and it should be open. Everybody bangs it when they enter or they leave.

MR. SCOTT: Therefore there was some grave doubt that the list would not be complete insofar as published reports and studies were concerned, though those reports and studies would be available generally to the public in libraries, research centres, and at the Queen's Printer. However, as a positive act of co-operation and to assist the participants in their research work, the Department of the Environment undertook to prepare immediately a complete list of all published reports and studies prepared by or for

the Department from January 1, 1970 up until the present. They undertook to give this matter some priority, and advised that that list would be available within the next three or four weeks. I emphasize, of course, that these documents would normally be available to participants in their research work anyway through libraries and other facilities.

The third matter, as an affirmative act of co-operation with the Inquiry, the Department of the Environment proposed to make available a copy of each unpublished report or study at Yellowknife. The procedure will be that when the Department can collect these unpublished reports and studies from their own files, they will be delivered to the Inquiry Offices at Yellowknife and we will develop a convenient system so that participants or others can inspect them at the Inquiry offices or copy them, if that is manageable, or in some cases borrow them under specific terms; so that the Department of the Environment went this far, that instead of requiring participants to go to Edmonton or Ottawa to see the unpublished material, they would undertake as an act of co-operation to make it available here in our library. The Department only wishes to emphasize that this unpublished material is made available to the Inquiry for the purposes of the Inquiry only, and for no other purpose.

The fourth matter is the matter to which Mr. Anthony particularly directed himself, perhaps, and that is the question of participants

constulting with officials with the Department of the Environment.

The Department advised us that it was anxious to ensure that each participant would have the opportunity if it desired to interview and consult with any official of the Department wherever he may be. Because, however, it was desirable that there should be some control of time allocation, these persons, and because they are not all physically available in convenient centres such as Ottawa and Edmonton, the following routine was proposed and is acceptable to Commission Counsel.

In the first place, the participant will make a personal arrangement with the official with whom he wishes to consult and provide notification that that arrangement has been made to Mr. Jack Etoch whose address I will provide later, but who is a senior official of the department at Edmonton.

The purpose of that notification is simply so that Mr. Etoch will have some knowledge of what his various officials and the other officials of the Department are doing.

So in the first place the participant will make a personal arrangement for interview or consultation directly with the official concerned.

In the second place participants -- it is expected -- will not invite or require officials in the Department of the Environment to perform research or other work, but will

utilize this Opportunity for the purposes of interviewing them, obtianing their knowledge and consulting with them.

In the third place, in the event that a participant is not certain which official he wishes to consult or in the event that the official is in a remote part of Canada, and interestingly enough, the example given for an Easterner, an odd one, was that New Brunswick was a remote part of Canada, and therefore that person is not easily available, the participant will make arrangements for that consultation directly with Mr. Etoch and all possible steps will be taken to see that the official of the Department is made available at a time and place that is convenient both to the participant and to him.

In the fourth place, participants will provide to Commission Counsel from time to time either before or after the event a list of persons in the Department with whom they have consulted.

In the fifth place, the Department wishes to emphasize that informal consultation will be permitted and encouraged by telephon e, for example, rather than by interview, as long as the fact of that consultation is communicated to Mr. Etoch and to Commission Counsel, either before or after the event.

Now, Mr. Commissioner, I think therefore, that in summary what can be said is that subject to physical availability and time

availability, any participant is now entitled to consult and interview any official of the Department, subject to those very modest restrictions that I have set out and it seems to me that there is no reason why, if that process is desired, it cannot begin immediately.

The next matter has to do with witnesses. The Department of the Environment indicated and confirmed the matter that Madame Sauve had set out in her letter to the Commission and that is that if participants wish officials of the Department to give evidence, they may make the normal arrangements that your rules contemplate for the calling of witnesses. I think it was made clear to us, that for example, if a participant wishes to call a certain official, he has simply to notify that official and to notify Mr. Etoch and arrangements will be made on the basis we outlined the other day relating to all government witnesses, in which he can be made available here to give evidence.

Again, because some of these persons may be remote from Yellowknife, it is desirable that participants give as much time, as much lead time to the potential witnesses as they can.

The sixth matter and again another matter that Mr. Anthony specifically referred to, relates to memoranda made in the Department with respect to preparation for a proposed intervention by the Department. We were advised that

in consideration of a proposed intervention in this INquiry by the Department of the Environment, the Department had set up an informal task force which was engaged, conducting a review of the application and a review of the Government assessment group's report and a request for supplementary information and the applicant's replies.

The Chairman of the Task force has -- is in the course of making a report, isolating certain areas of concern which developed. That report is not yet available but we have been provided with two documents, first of all, a digest of the material that will be contained in that report and in the second place, a list of witnesses prepared by the Department task force, setting out names of people, both within and without the Department, who it was thought had expertise that might bear on the areas concerned. WE have had copies of that material made and it is available and will be circulated to every participant today.

When the more formal report of the Department is available, it will, of course, be provided, but I think that it is safe to say that the digest is a complete and full synopsis of the material that will be contained in that report.

Therefore, Mr. Commissioner, I think that we are able to report that as a result of Madame Sauve's letter and our meeting on Sunday, the Department of the Environment has exhibited, if I may say this, a very, very high level of

co-operation with the Inquiry and a scheme has been developed, whereby the promise of the Department that it would open all doors is being realized and I particularly am grateful to Dr. Tener and his officials for the dispatch with which they responded to the INquiry's concern in these areas. It need hardly be said that there may be, from time to time, particular difficulties relating to the whereabouts of a particular official or such matters. The Department wishes to emphasize that it will take all reasonable steps, with all dispatch, to dissolve those and it seems to me that if they occur from time to time, if they come to the attention of the participants from time to time, it would be a happy start if they could bring those difficulties to our attention first and we will attempt to use our good offices to iron them out.

Again, I simply want to say that I am grateful for what I think is a very high standard of co-operation and openess that the Department has proposed by these suggestions. I think that that is all I have to say at this stage, sir. That material will be circulated today to the participants.

MR. GENEST: May it please you, Mr. Commissioner, after being absent from your hearings for a few days and reading what went on after I left, I might be permitted to say that we are now going to start the non-controversial part of the hearings.

Before beginning, sir, I wonder if it would be convenient. I have proposed to my learned friend, Mr. Scott, and those of the participants who I could see yesterday that it might be convenient to the Inquiry if we filed at this time in view of exhibit numbers, subject to whatever requirements of proof may be imposed, the basic documents on which the application is based, that is, the various exhibits to the application. The application to the Minister for a grant of right-of-way was of course filed at the preliminary hearings and was given the number Exhibit 3, and I wonder if I might be permitted to file the supporting exhibits which will be referred to throughout the evidence of Arctic Gas during these many months and it might be more convenient if I did it all in a block this morning and identified the documents. Would that be satisfactory, sir?

THE COMMISSIONER:: Yes. I think it would be, if no one has a better proposal.

MR. GENEST: I have provided the -- is it the Registrar Staff, sir -- the Commission Secretariat with the documents that I propose to file and they are as follows:

The first will be a volume containing application materials with reference to location, design and facilities of capacities. It covers Sections 8 and 9 -- It is not the facilities-- of capacities, I am told that it is the capacity of the facilities.

I do not know how we want to proceed, sir. Do we give these each an individual exhibit number?

THE COMMISSIONER: I would think we ought to -- Mr. Scott, you assist us, if you think we are on the wrong track?

MR. SCOTT: I think we should, Mr. Commissioner. It would be easier.

MR. GENEST: And the last exhibit according to the list supplied to me by Mr. Waddell was exhibit 48 which was a submission by the NOrthwest Territories Chamber of Commerce. So I do not know if you want to start over. I thin k perhaps -- I think we agreed that to save confusion we should just keep on going in numerical order.

THE COMMISSIONER: I think Mr. Waddell -- has an addendum there.

MR. GENEST: Five more Mr. Waddell says, so 48 plus five is 53. This should then be 54.

(VOLUME WITH REFERENCE TO LOCATION, DESIGN AND CAPACITY OF FACILITIES MARKED AS EXHIBIT NO. 54.)

MR. GENEST: The next exhibit, sir, is a volume entitled Construction Plan Operations and Maintenance Plans which covers Sections 13 (a) and 13 (b) of the application materials and that will be Exhibit 55.

(VOLUME ENTITLED "CONSTRUCTION PLAN OPERATIONS AND MAINTENANCE PLANS MARKED AS EXHIBIT NO. 55.)

MR. GENEST: The next volume is a volume entitled "Regional Socio-Economic Impact Statement" covering Section 14 (c) of the application and with your leave, sir, that would be Exhibit 56.

(VOLUME ENTITLED "REGIONAL SOCIO-ECONOMIC IMPACT STATEMENT" MARKED AS EXHIBIT NO. 56.)

MR. GENEST: The next is the applicant's environmental statement, north of the 60th Parallel covering Section 14-(b)(n), and that will be Exhibit 57.

(APPLICANT'S ENVIRONMENT STATEMENT NORTH OF 60th PARALLEL MARKED EXHIBIT 57)

MR. GENEST: The next is the volume entitled:

"Northerner Training Program,"

and this covers Section 14(x) of the application materials. That will be Exhibit 58)

(NORTHERNER TRAINING PROGRAM MARKED EXHIBIT 58)

MR. GENEST: The next is Exhibit 59, a volume covering alternative corridors governing section 14(e) of the application materials, which will be No. 59.

(ALTERNATIVE CORRIDORS VOLUME MARKED EXHIBIT 59)

MR. GENEST: And following which is a companion volume which contains alternative corridor drawings covering Section 14(e)(i)-(x) of the application materials.

(ALTERNATIVE CORRIDOR DRAWINGS VOLUME MARKED EXHIBIT 60)

MR. GENEST: Then there are a series of exhibits covering design drawings and alignment sheets, the first of which would be a very unwieldy document entitled:

"Design drawings, Section 8(b)(c) and flow diagrams, Section 8(b)(iv)."

(DESIGN DRAWINGS & ALIGNMENT SHEETS MARKED

(EXHIBIT 61)

MR. GENEST: Then there is alignment sheets showing the detail of the pipeline materials -- what was the last number? The former document, the design drawings was No. 61; and the next one will be an alignment sheet showing the detail of a pipeline route north of the 60th Parallel.

(ALIGNMENT SHEET SHOWING DETAIL OF PIPELINE NORTH OF 60th PARALLEL MARKED EXHIBIT 62)

MR. GENEST: Then another alignment sheet for the interior route entitled:

"Alignment sheets and full diagrams, interior alternative pipeline route, Prudhoe Bay to Travaillant Lake junction via the main branch of the Canning River."

(ALIGNMENT SHEET FOR INTERIOR ROUTE MARKED EXHIBIT 63)

MR. GENEST: And a similar document covering the same ground except it's via the Marsh Fork of the Canning River.

(ALIGNMENT SHEET VIA MARSH FORK OF CANNING RIVER MARKED EXHIBIT 64)

MR. GENEST: Then, sir, there is an amendment to the application to the Minister himself entitled:

"The first amendment to the application to the Department of Indian Affairs & Northern Development,"

which deals, sir, with the route change in the Fort Simpson area.

(FIRST AMENDMENT TO APPLICATION MARKED EXHIBIT 65)

MR. GENEST: That will be No. 65. Then there is a companion volume to that, really two, there is an amendment to the information given in the Sections 8-A, 8-B, 13-A and 14-D. Perhaps we can entitle that an exhibit in support of the Fort Simpson amendment, which will be No. 66.

(VOLUME RE FORT SIMPSON AMENDMENT MARKED EXHIBIT 66)

MR. GENEST: And there is an alignment sheet also relating to the Fort Simpson amendment, and in the same document is an amendment to the design drawings with reference to the alignment sheet.

(ALIGNMENT SHEET RE FORT SIMPSON AMENDMENT & AMENDMENT TO DESIGN DRAWINGS MARKED EXHIBIT 67)

MR. GENEST: And then, sir, I understood counsel was going to be filing the Mackenzie Valley Pipeline assessment prepared by the Pipeline Application Assessment Group, otherwise known as PAAG, and the government's Assessment Group, otherwise known as GAG. I would think they would prefer the first.

MR. SCOTT: I presume, Mr. Genest, we've heard the end of that rather tired joke by now.

MR. GENEST: I wasn't sure. I thought I'd have my crack at it and then it will never be heard again.

MR. SCOTT: It might be

convenient to give, if you are finished with your primary filings, if you --

MR. GENEST: Well, I was going to file our response.

MR. SCOTT: Well, why don't we, in chronology why don't we file the requests for supplementary information first, and that's called

"Requests for supplementary information concerning Canadian Arctic Gas Pipeline Limited."

Could it be given, Mr. Commissioner, the next exhibit number, which is 68?

(REQUESTS FOR SUPPLEMENTARY INFORMATION RE CANADIAN ARCTIC GAS PIPELINE LTD. MARKED EXHIBIT 68)

MR. SCOTT: Then Mr. Genest perhaps will file the replies which are contained in a brown volume.

MR. GENEST: Well, if we are going to go by the strict order of chronology, the report came before the replies.

MR. SCOTT: All right, Mr. Genest. No. 69 then, Mr. Commissioner, should be the report of the Pipeline Application Assessment Group, entitled:

"M ackenzie Valley Pipeline Assessment,"

which is the document with the handsome cover.

(MACKENZIE VALLEY PIPELINE ASSESSMENT MARKED EXHIBIT 69)

MR. SCOTT: And No. 70 should be the replies of Arctic Gas to the requests for

supplementary information, which is entitled:

"Responses to Pipeline Application Assessment Group Requests for Supplementary Information,"

and is the brown volume. It might be convenient at this time also to give the next exhibit number to a document entitled:

"An Index to the application of Canadian Arctic Gas Pipeline Limited with particular reference to environmental and technical topics."

That index was prepared by the Pipeline Application Assessment Group. What number is that?

MR. GENEST: 71.

MR. SCOTT: And that, I think, should be Exhibit No. 71.

(REPONSES TO PAAG REQUESTS FOR SUPPLEMENTARY INFORMATION MARKED EXHIBIT 70)

(INDEX TO APPLICATION MARKED EXHIBIT 71)

MR. SCOTT: All those are filed, so far as we're concerned, subject to the required proof.

MR. ANTHONY: Mr. Commissioner, may I just direct a question to Mr. Genest? My understanding of Exhibit 3, the application, is in fact the thin application volume. We now have further exhibits as outlined by Mr. Genest, and I was wondering whether it was the intention of Arctic Gas to also file Sections 4, 5, and 6 which were filed with the N.E.B. as part of the application, but have not as yet been filed before this Commission?

MR. GENEST: Well, sir, my intentions are subject to change from time to time, but at the present it's not my intention to file these because my present belief, which may be based on an ignorance of some of the issues involved, is that they are not relevant to the concerns with which -- with the investigation with which you are charged.

MR. ANTHONY: Mr. Commissioner, if I may then make the request of Arctic Gas that this information be filed? In Section 8(a).3 they discussed the questions generally of gas supply area, as it relates to routing in particular, and they talk about expected supply and flow-through and expected capacity, and I think those are covered in Section 4, entitled:

"Gas supply areas,"

Section 5, "Gas supply reserves," and
Section 6, "Gas supply deliverability."
I think it may be helpful if that was before us, even though the exact issue may not be subject to detailed consideration.

THE COMMISSIONER: May I make a suggestion, Mr. Genest, so we don't get bogged down in an argument. Why don't you file them and have them marked, reserving your right to take the view that not everything in them is necessarily relevant?

MR. GENEST: That was my concern, sir, that will be quite satisfactory. I don't think I have them here today, but they will be put in in due course.

MR. GIBBS: Mr. Commissioner, along the lines of what Mr. Anthony has said, in my submission there are at least two other documents that fall into that category of material, and which my friend, Mr. Genest, may not want to file but which in my submission is relevant to this hearing. One is the financing of the project and I suggest to you, sir, that it is relevant because you're directed to consider the social and economic impact regionally and of course an impact on Canada must be reflected within its regions.

There is a second reason, sir, and that is that part of the financial material is the cost of service, and the cost of service must apply to the service to northern communities, so in my submission that finance volume ought to be filed, and as well my recollection, Sir, is that there is one dealing with the impact on the Canadian economy and for the same reasons, because that is reflected regionally, in my submission that also ought to be filed by Canadian Arctic Gas.

THE COMMISSIONER; Well,

Mr. Genest, why don't you file all of those on the same footing?

MR. GENEST: I wouldn't like it to be taken by filing them that we agree at all with Mr. Gibbs' position which seems to be directed at just having two National Energy Board applications, a dry run here and one down in Ottawa. But I'll accept that suggestion, sir, reserving my rights.

THE COMMISSIONER: I should say that all of the material that Arctic Gas filed with the National Energy Board in support of its application with the National Energy Board was filed concurrently with the Minister of Indian Affairs & Northern Development, and all of it was turned over to the Inquiry by the Minister, and the additions to the material have been sent directly to the Inquiry since, by Arctic Gas. I'm speaking of the formal volumes that it seems to me are under discussion here this morning.

MR. GENEST: Sir, I believe that as far as the documents filed in support of the application to the Minister they are identified in Schedule "A" to the application, which is Exhibit 3 in these proceedings, and it does not contain the documents referred to by my learned friends this morning. What was placed before the Minister in support of the application for a grant of right-of-way are the documents that I filed today, plus of course the amendments that I filed today.

THE COMMISSIONER: Well --

MR. GENEST: The other documents may have been provided, but they were as a matter of information.

I may be quibbling, and -- but there will come a time when it will be more than a quibble because it seems to me, sir, that we have to keep the concerns of this Inquiry in proportion, and that you could spend months examining eco subjects which will be ex haustibly examined by the National Energy Board. But I will arrange to have these here, reserving my rights.

MR. SCOTT: And I presume, Mr. Commissioner, that reserving Mr. Genest's rights they will be given exhibit numbers when they're made available?

MR. GENEST: Mr. Commissioner, I wonder if I could reserve on that question? It affects other hearings. I undertake to deal with it first thing tomorrow morning, if that's -- I would not like to be pinned down at this moment. There may be a consequence of my filing an exhibit that I've estopped myself or foreclosed myself. I would like to consider my position in that respect. These documents are, of course, available and can be used by any party in cross-examination; but I certainly don't propose to make them part of my case. I thought the exercise of filing exhibits were those documents upon which I was relying in support of the evidence I was adducing before these hearings, so I am not prepared at this time to give an undertaking that I will file

them as my exhibits. I'll make them available, I'm prepared to go that far.

THE COMMISSIONER: Mr. Genest, I think I should say that last year in April and in May, I held Preliminary Hearings in Yellowknife, Inuvik, Whitehorse, and Ottawa, in which there was a great deal said on every side about the scope of this Inquiry's work and I laid down rulings that were designed to limit, generally, the scope of this Inquiry, and I think that all counsel have studied those rulings and I hope that in embarking upon the consideration of the evidence all counsel will bear those rulings in mind because I don't think there's anything to be gained by threshing all of those questions out again.

MR. GENEST: Well, sir, I certainly didn't want to be taken -- I want to say I read your rulings every night before I go to bed and discover something new.

THE COMMISSIONER: They would put you to sleep, I suppose.

MR. GENEST: I certainly appreciate the scope of the Inquiry. I appreciate also that while some subjects impinge, you have faced broad limits and I certainly do not want to argue that matter again. Perhaps my concerns that I have this morning will all go away this afternoon and tomorrow you will get exhibits.

I would just like to have a little time to consider that.

THE COMMISSIONER: By all means.

MR. SCOTT: Mr. Commissioner, before Mr. Genest begins, could I raise one matter that I think should be dealt with generally? Mr. Genest has now filed the summaries that are required by the rulings with respect to Panels 1 and Panels 2.

MR. GENEST: Panel 3 this morning.

MR. SCOTT: Well, I don't seem to have run across it yet and I want to deal just with Panel 1 and Panel 2.

We will learn as we go along, I've no doubt that these summaries are full and complete summaries of the evidence that will be given but I am concerned about one point, dealing with Panel 1 on page 14, the summary provides as follows:

> "The panel will be asked to review the concerns raised by the Government Assessment Group Report and the response of the panel to such concerns."

I am not at the moment satisfied, Mr. Commissioner, that that is a summary of the evidence that will be dealt with under that head. I would have thought, and I've no doubt it may be possible to do it in subsequent panels, that if such a subject is to be dealt with, the applicant in his summary will be able to give us a reference to the paragraphs in the Assessment Group Report, or in the replies for supplementary information, and a reference to the paragraphs in the Arctic Gas Replies so that we may narrow down and know a little more precisely the matters that the applicant proposes to deal with in that area in each panel. I think also

it would be helpful if in the summaries, the applicant were to set out whether his response to the Assessment Group's enquiry, if that it be, in any given case, will go beyond the response that is set out in the replies of Arctic Gas. So that applicants will not be confronted with new material, so that participants will not be confronted with new material without notice.

Now I have spoken to Mr. Genest about that earlier and I think he accepts the general proposition I advanced, and will attempt to assist us more precisely in the future; but I would just as a matter of record ask him to confirm that.

MR. GENEST: I do, sir. I think Mr. Scott has a point. The original thought was that the parties had the assessment and the responses but I agree they are voluminous and it's difficult to find them, and I am going to try and provide some more information on the second panel and it's a little late for the first panel now. I don't think we're dealing with very many, and we're dealing with them only in a rather general way. This becomes more acute in subsequent panels, and I undertake to provide a fuller statement of that topic.

As I say, we're experimenting and hope to improve as time goes on.

THE COMMISSIONER: I should say that Miss Hutchinson is the secretary to the Inquiry, and responsible for the exhibits. She is the custodian of the exhibits.

MR. GENEST: Sir, we're

now starting the evidence in chief of Arctic Gas on the first phase of this Inquiry, and that, sir, will be covered in four panels, the first of which I will be calling shortly, the panel which is going to deal very briefly with the process of route selection, explain the route and explain in general terms how it was arrived at, and the processes that were employed.

The second panel, a panel headed by Dr.Clark, will deal with the geotechnical aspects of the engineering of the pipeline.

Things such as river crossings, bank stability and so on.

A third panel will deal with the nuts and bolts, if I may call them that, of the engineering, the metallurgy of the pipeline, the metallurgical problems that can be anticipated and how we propose to deal with them.

The fourth panel will deal with the construction plan of the pipeline covering such things as schedules, logistics, when we plan to be in such-and-such a place, and sir, I propose to call -- to end our evidence in chief on this phase, Mr. Horty, assisted by the panel of two or three witnesses, to deal with the policy matters that have arisen out of the subject matters dealt with by the previous witnesses. These are experts, I'm sure it would be helpful to the Commission to hear from a senior officer of the company as to what it undertakes to do and proposes to do and to deal with these related subjects.

I have run into some -- within my own grasp, if you call it -- into some problems as to how to give a complete outline of the evidence of the policy witness. We are going to provide, as soon as possible, the parties with those policy issues that we see presenting themselves out of our examination in chief, but it is a little hard to anticipate what is going to arise out of the cross-examination of the parties. So this may have to come in pieces. We'll try and do our best to give a statement

within that two-week limitation , sir, that your rulings have imposed. But I ask in advance for some flexibility as regards that kind of witness.

THE COMMISSIONER: Maybe counsel can, among themselves, make some progress in determining the extent to which Mr. Horty might be questioned, because we wouldn't want the whole of the time he is here as a witness to be spent in legal arguments.

MR. GENEST: Then, sir, if I might call my first panel of witnesses consisting of Mr. P.H. Dau, Mr. G.L. Williams, Mr. D.W. Watson, and Dr. J.D. Mollard. I wonder, while they take their places, sir, the summary of evidence that I have provided to the parties, contains a statement of the position and the educational background and qualifications of these witnesses. I would, rather than read them at great length into the record, I think Dr. Mollard would take us the morning, I wonder if I might just file these as an exhibit and highlight the witnesses, if that would be satisfactory to my friends?

I have extra copies available. I think all my friends have a resume which was provided with the summary of evidence, and if I might then file with the secretary an exhibit consisting of the qualifications and educational background of the witnesses.

We were also asked, sir, to provide the participants and I think in fact

your ruling required that we do this, with a list of the documents which these witnesses have referred to or relied -- or may refer to or rely upon in connection with their testimony, and I thought it might be convenient if that was filed as an exhibit also. Then if I then might file with the secretary as the next exhibit a list of reports relied upon by this panel?

MR. SCOTT: Mr. Commissioner, I have no objection to that mode of proceeding, but I think it would be helpful not only to counsel but to others who are in the room if my friend would lead the witnesses to a brief account of their expertise and their --

MR. GENEST: Oh, I propose to do that.

MR. SCOTT: -- background.

MR. GENEST: I propose to do that. May the panel be sworn, Mr. Commissioner?

GUY LESLIE WILLIAMS, sworn:

THE SECRETARY: State your full name, please.

A Guy Leslie Williams.

JOHN DOUGLAS MOLLARD, sworn:

THE SECRETARY: State your full name, please.

A John Douglas Mollard.

DAVID WILLIAM WATSON, sworn:

THE SECRETARY: State your full name, please.

A David William Watson.

PHILIP HARVEY DAU, sworn:

THE SECRETARY: State your fullname, please.

A Philip Harvey Dau.

DIRECT EXAMINATION BY MR. GENEST:

Q Mr. Dau, you're the gentleman on the left of the panel, perhaps I could -- we've got some signs here but they're illegible even to me. This is Mr. Dau, this is Mr. Williams, next to him is Dr. Mollard, and at the end is Mr. Watson.

Mr. Dau, perhaps I can start with you. You are Philip Harvey Dau, and you are the president and chief executive officer of Northern Engineering Services Company Limited.

A Yes.

Q Could you tell us what that is, very briefly?

A It's a consulting engineering group that has been formed to perform engineering services for Canadian Arctic Gas.

Q And what kind of a staff has it got, roughly?

A Roughly a total staff of about 150, of which 100 approximately are professional men, draughting and technicians.

Q And sir, you graduated from the University of Alberta in Edmonton in 1948 with a degree of a Bachelor of Science in Civil

Engineering, is that correct?

A Yes sir.

Q And you're a member of the Association of Professional Engineers, Geologists and Geophysicists of Alberta, the Engineering Institute of Canada, and the Canadian Society of Mechanical Engineers.

A Yes sir.

Q And you spent a couple of years as engineer for a firm of municipal consulting engineers.

A Yes sir.

Q And then you were employed from 1950 to 1954 as the construction superintendent and chief engineer for Sparling-Davis, and that was a firm engaged in pipeline construction.

A Yes sir.

Q And for the next eight years you were employed with Dutton, Williams Brothers,

A Yes sir.

Q What kind of firm was that, Mr. Dau?

A They were both consulting engineers and contractors, and I had some experience in both fields.

Q You became manager of operations of that firm in 1958?

A Yes sir.

Q And were you involved in pipeline projects during that time?

A Yes, very many.

Q Would you outline them, please?

A We had numerous clients in western and Northern Canada, including Alberta Gas Trunkline, Trans-Canada Pipeline, Westcoast Transmission, Inland Natural Gas, Pacific Petroleums, Gulf Oil Canada, Federated Pipelines, and so forth. These involved engineering and construction, up to a certain moment in time, in oil and gas pipeline systems.

Q And that takes us till 1962, when you were appointed, I understand, vice-president of engineering of Williams Brothers Canada Limited.

A Yes sir.

Q And that was -- what was that, a successor to the former firm you were with?

A Yes sir.

Q And you, I think in your summary, stated that Williams Brothers in 1964 ceased its construction activities --

A Yes.

Q -- and what did you do then?

A Specialized in consulting, in consulting engineering, construction and project management services.

Q To whom, to anybody, or were you specialized in one industry or one field?

A Primarily in the pipeline field, although there was some minor amount of work in other fields.

Q And you were appointed president of this firm in 1971, is that correct?

A Yes sir.

Q And sir, what was your area of responsibility with reference to the evidence with which this panel is going to deal?

A Well, as president, I am responsible for all aspects of the work of Northern Engineering, and specifically relating to facilities location, connecting pipeline facilities, construction plans and alternate corridors.

Q And perhaps I can move to you, Mr. Williams. How old are you, sir?

WITNESS WILLIAMS: 52.

Q And you're now director of field services for Northern Engineering Services.

A Yes sir.

Q And you were formerly employed by Williams Brothers Canada Limited, which was Mr. Dau's firm?

A Yes sir.

Q How long had you been with them?

A Including my time with Northern Engineering, 18 years.

Q And you graduated also in 1948 with a B.Sc. in civil engineering from the

University of Saskatchewan.

A Yes sir.

Q And you're a professional engineer and you belong to the Associations of Professional Engineers set out in the exhibit listing your qualifications. Is that correct.

A Yes sir.

(QUALIFICATIONS OF PANEL 1 MARKED EXHIBIT 72)

(LIST OF DOCUMENTS REFERRED TO BY PANEL 1 MARKED EXHIBIT 73)

MR. GENEST: Q You were with the Canadian Pacific Railway from 1948 to 1957. What was your experience there?

A This work was mainly with respect to construction and maintenance of tracks, buildings, bridges, fuel and water facilities, and I left the C.P.R. in 1957 as assistant division engineer in Calgary.

Q And from there where did you go?

A To the firm of -- it was Dutton-Williams then, at that time.

MR. GENEST:

Q Is that when you became associated to Mr. Dau?

A That is correct.

Q And what kind of work did you do at Dutton Williams?

A Very similar to what Mr. Dau has outlined. BOth in the early years in construction and more laterly in engineering, consulting and project management to the petroleum industry and mainly in Western Canada.

Q And in 1963 you became a project manager with the Williams Brothers?

A Yes, sir.

Q And what was your experience then with pipelines following that appointment?

A The largest project that I worked on as project manager was the 570 miles of Products Pipeline from Empress, Alberta to Winnipeg, Manitoba and also in other oil and gas gathering systems in Alberta and feasibility of slurry pipeline studies from Saskatchewan and Alberta to Vancouver.

Q And you were assigned to northern engineering services in 1972?

A Yes, sir.

Q And you have been concerned with this project since that time?

A Yes, I have.

Q And your area of

responsibility was what, sir?

A I supervised the construction of the Sans Saulttest facility and have worked in the area of route location and terrain evaluation and construction planning.

Q Did you have any connection with this project before the formation of Northern Engineering?

A Yes, sir. Almost from the inception of our work in 1969 I --for the first year on a part-time basis and from 1970 on on a full-time basis.

Q So you have been engaged on this work on this project since 1970 on a full-time basis?

A Yes, sir.

Q Mr. Watson, sir, if I could move to you. You are at the end of the table.

MR. WATSON:

Right.

Q You are a professional engineer?

A That is correct.

Q You are with northern Engineering Services Company Limited?

A Yes, I am.

Q And you graduated in 1964 with a degree in mechanical engineering from the University of Saskatchewan?

A Yes.

Q And you belong to the usual professional associations?

A Right.

Q And from 1964 to 1967 you were with the Steel Company of Canada?

A that is correct.

Q And what kind of work were you doing there?

A Well, I worked in a number of departments with the Steel Company of Canada and these included the industrial engineering department, the engineering department itself and purchasing.

Q and in 1967 you joined Williams Brothers?

A That is right.

Q and what have you been doing there -- what did you do there?

A The first project that I worked on was the engineering inspection and supervision of a couple of natural gas dehydration plants that are located in northern British Columbia. I was involved in design and engineering and construction/inspection of a crude oil gathering system. I was also involved in numerous feasibility studies and cost estimates for crude oil and natural gas pipelines and gatherin g systems and I assisted in the planning and the layout and construction supervision of the Sans Sault Rapids test facility. This was for the Northwest project study group.

Q Which was a predecessor

to the Canadian Arctic Gas study?

A that is correct.

Q And what was your area of responsibility?

A With Northern Engineering

Q Yes.

A The prime area of responsibility was with the alignment sheets, I co-ordinated the gathering of the data that went on to the sheets from the various departments within Northern Engineering and third party consultants and I ensured that this was placed on the sheets. I was also involved in detailed route selection that applies on the alignment sheets.

Q Now, Dr. Mollard, if I may turn to you, sir, you are the President of J.D. Mollard and Associates Limited.

WITNESS MOLLARD:

A Yes, sir.

Q And what is that firm, Dr. Mollard?

A We are a firm that specializes in the interpretation of aerial photographs and ground water studies. THose are our two main areas of specialization and in air photo interpretation our main primary fields are route and site selection. We have done about 250 of those projects, examine gravel and various kinds of bore hole searches -- we have done about 500 of those kind of searches, so those are the main areas: sites and routes, bore

hole and ground water.

Q And as to your educational background, sir, you obtained a B.Sc. in Civil Engineering in 1945, a Master of Science -- that was from the University of Saskatchewan, the first one and then you went to Purdue and you got a Master of Science in the same subject and you obtained a Doctorate in civil Engineering from Cornell in 1952, is that correct?

A Well, yes, really -- in both my Masters and my Doctors I took about half of my classes in civil engineering and about half in geology and related subjects. So it is really -- I graduated in Civil engineering, but half my course work was in geology.

Q And you belong to the professional associations which are quite numerous which are listed in the exhibit?

A Yes, I do.

Q And as far as your professional experience is concerned, sir, you started in 1945, did you?

A That is right.

Q As a construction engineer for the Saskatchewan Department of Highways?

A Yes.

Q You were employed for awhile as an air surveys engineer -- that is in-between your acquisition of degrees. You were an instructor at Cornell in the School of Engineering, is

that correct?

A That is right.

Q In 1952 I note that it says that you were research engineer at the School of Civil Engineering at Cornell. What dos that mean?

A Well, we were doing a study of the -- of beaches and the ability of beach materials to support various kinds of land and water equipment moving across the beach and we had about eight or ten beaches that we studied from aerial photographs and on the ground. So, that was about a year long job with research and individual project there.

Q Was this in connection with the Korean War, Dr. Mollard?

A Well, I did work on the Korean War where we were interpreting aerail photographs and identifying vegetation and relief and various aspects of terrain as it affected movement of vehicles and build up of --

I might say that in 1946 -- that was one that you skipped there, that was the first association with permafrost -- I had actually at Purdue University in 1945, as a student there, mapping permafrost in Alaska, which is possibly relevant to this.

Q Right.

And then in 1953 you became a chief of the airphoto analysis and engineering

geology division of an initial that I forget what it stands for -- P.F.R.A. What was that?

A That is Prairie Farm Rehabilitation Administration. They were concerned with water and so on .

Q You had better take that slowly for the reporters, what was it?

A Prairie Farm Rehabilita--

Q Prairie Farm -- I am sorry, I thought it was a scientific term --

A Prairie Farm Rehabilitation Administration and that is really a branch of the Canada Department of Agriculture and we were concerned with irrigation and dam sites in WEstern Canada, the prairies, really.

Q And you were the technical advisor from 1954 to 55 to the Governments of Ceylon and West Pakistan on the same kind of work, is that correct?

A Well, actually I was advisor on setting up a broad resource survey in WEst Pakistan and then a year or two later in Ceylon there were several components, one in geology, one in agriculture and one in forestry.

Q And since 1956 you have been a consultant.

A That is right.

Q And heading your own firm. Do you lecture, sir, at any educational institutions?

A Yes, I usually lecture at least once a year and sometimes twice a year for about a week and next week I am going down ot to the University of Alberta and I have 60 people coming there for a lecture -- so that is a fairly standard, yearly thing.

Q And have you had experience in connection with the specialty which you have with pipeline routes and the assessment of pipeline routes, the assessment of soils or terrain conditions to assist in the planning of pipeline routes?

A Well -- I am -- going to fall down a crack here --

Q That is a polygon ice wedge --

A That is an ice wedge, polygon --

Yes, I cannot say exactly how many pipeline projects that I have worked on from memory, I mentioned that we have done roughly 200 route surveys and many of those have been pipeline studies over a period of 17 years and some of them in the north in permafrost areas.

Q Do you know of any firm in Canada that has done more than yours? In that specialty?

A Well, I am not aware of it --

Q And then we have listed as an appendix -- I am not gong to try -- you have been

the -- certainly what I would call the prolific writer? -- you have as appendix B of your qualifications some 9 pages of publications that you -- you have written extensively in your field, have you, sir, may I sum it up that way.

A Those are my published papers, I guess.

Q Well, may I turn then to Mr. Dau and ask you if you would, Mr. Dau, describe to the Commissioner the involvement of the various members of your panel with this project and take it in two stages, let us start prior to the formation of Northern Engineering Services.

WITNESS DAU: Williams Brothers Canada Limited were retained in 1967, by some of the present member companies in the Arctic Gas Study Group, to investigate the feasibility of a natural gas pipeline from the potential producing areas of Northwest Canada to the market areas in the Great Lakes area of Canada and the United States. At that time, the prime potential producing area was considered to be the south-eastern portion of the Yukon Territories and the south-western portion of the Northwest Territories in the Fort Liard area.

Q If I could interrupt you there, Mr. Dau, there was no -- at that time the delta gas potential had not been thought of, or at least explored, or what was its status?

A It was not considered to have enough potential at that time to warrant studies for that additional distance.

Q Would you proceed, please?

A In 1969 discussions were held with producing companies, with potential production in Northwest Canada and Alaska, with the result that the original assignment was expanded to include the potential producing areas of the Mackenzie Delta and Prudhoe Bay in Alaska. By this time, of course, there had been discoveries in Prudhoe Bay.

This assignment resulted in numerous investigations and studies of alternate routes and system configurations, environmental and

technical research, construction and operation of northern test facilities, and investigations into the technical and economic feasibility of the systems. All of the members of this panel were involved in that work.

Q And then, sir, we discussed it a little bit when I went over your qualifications, but perhaps you could tell us a little more about the -- what Northern Engineering Services is, how it was formed, how it operates?

A Yes sir. Northern Engineering Services Company Limited is a company incorporated under the laws of the Province of Alberta, and is registered extra-provincially in the Yukon and Northwest Territories, and in the Provinces of British Columbia, Saskatchewan and Manitoba. Northern Engineering Services Company Limited was formed by Williams Brothers Canada Limited and Pemcan Services. Pemcan Services is a joint venture consisting of Techman Ltd., Shawinigan Engineering Co. Ltd., --

Q Techman, T-E-C-H-M-A-N?

A Yes sir. Montreal Engineering Company Limited, and R.M. Hardy & Associates Ltd.

Williams Brothers Canada is a consulting company specializing in the design, engineering and construction management of pipeline systems. Techman Ltd. is the technical arm of the Loram Group, L-O-R-A-M Group of companies in Calgary.

Q What are they?

A The Loram Group of

companies include construction, engineering, mining, and many others.

Q And Shawinigan Engineering?

A Yes sir, Shawinigan Engineering Co. Ltd. and Montreal Engineering Company Limited are large Canadian companies specializing in the petrochemical and electrical power fields. R.M. Hardy & Associates is a consulting geotechnical and materials engineering group.

Q I take it that you drew on the staff of all of these organizations to form the staff of Northern Engineering?

A That is correct.

Q You, for instance, have been seconded from Williams Brothers along with Mr. Williams?

A Yes, we have seconded people and of course Northern as a company itself has their own employees which were hired specifically by Northern.

Q And what was the assignment given to Northern Engineering?

A Our assignment is to provide the engineering, environmental and other related technical services necessary to determine the feasibility of an appropriate and efficient method of constructing a pipeline system to transport natural gas from Northern Alaska and Northwest Canada to points as far south as the border between Canada and the lower 48 states of America,

and to prepare and cause to be prepared applications for necessary governmental authorities to construct and operate the pipeline described in the application, to prepare and furnish for financing purposes, all necessary and allied information, to furnish plans, recommendations and reports as may be required, to prepare and present, through qualified experts, testimony at regulatory proceedings and to perform other engineering and related services as requested by Canadian Arctic Gas Study Limited.

Q That signs like language taken from a contract.

A It was written by a lawyer, sir.

Q What did you really do?

A We have performed all of the engineering and research functions for Arctic Gas, and all of those -- all of the research and all of the engineering has not been done by Northern itself. In many instances Northern did not have the particular expertise that was required and we have retained third party consultants for those specialized fields , such as metallurgy, for instance. Others in the geological area, and certainly a lot in the environmental area, we retained many environmental consultants.

Q But you held the strings, subject to Arctic Gas's --

A Yes sir.

Q -- contract with you.

A Yes sir.

Q And I think I asked you, you have a staff of approximately how many?

A A total staff at the present moment of about 150.

Q That's a hundred, you said, were professionals.

A Professional staff, technicians and draughtsmen. There are, I believe, about -- I think the number is approximately 80 professional staff at the present moment.

Q And you work, sir, exclusively for Arctic Gas?

A Yes sir.

THE COMMISSIONER: By "professional", sir you mean professional engineers, I take it?

A Professional engineers, biologists, and so on. They have a degree in a particular field.

MR. GENEST: Thank you for clearing that up, sir.

I am moving to another subject, sir. I don't know whether it's your usual time to take a break or not. I'm in your hands, but this would be convenient if you're so moved; or I can go on. I'm in your hands.

THE COMMISSIONER: Well, what do you say, Mr. Scott? I have the feeling we just got started, but I see it's 10:30, so --

MR. SCOTT: It's a matter of indifference to me, Mr. Chairman.

THE COMMISSIONER: Let's take a break now, Mr. Genest. 10 minutes? 15 minutes?

(PROCEEDINGS ADJOURNED FOR 15 MINUTES)

(PROCEEDINGS RESUMED PURSUANT TO ADJOURNMENT)

MR. SCOTT: Mr. Commissioner, can I suggest that as a matter of convenience that counsel should be permitted to sit when they ask questions or make rejoinders?

THE COMMISSIONER: Yes, counsel may sit or stand at their convenience, what-ver suits them and it is entirely acceptable to me whichever they chose.

MR. GENEST: Thank you very much, sir.

Mr. Commissioner, before I go on to the next subject with this panel which is a description of the location of the pipeline, perhaps it might be useful if everyone had with them volume -- the volume entitled "Location Design and Capacity of Facilities in Connection Pipeline Facilities" and we will be referring, sir, in the course of this evidence to the alignment sheet which is headed, "Alignment Sheets North of 60". Which exhibit is that? -- Exhibit 62, and we will also be referring a little later on to the Fort Simpson amendment volume which is Exhibit 67 -- No, no, -- that is the book on Fort Simpson -- 66, Exhibit 66. It might be useful if I indicated that so that the volumes are handy.

Q Mr. Dau, I wonder sir, if you could -- we have had this before, but it might be useful to have it again --if you could describe the location of the prime route and the ancilliary facilities which Arctic Gas proposes

to construct and perhaps we could have the assistance of one of the members of your panel to indicate it on the map that is on the wall.

WITNESS DAU:

A The location of the facilities proposed by Arctic Gas are described in considerable detail in Section 8 (a) of the application -- I am not sure of the Exhibit number as originally filed, which includes the two volumes of alignment sheets, north and south of the 60th parallel. A revision was made to the original filing incorporating the route change near Fort Simpson. That document has an alignment sheet which is Drawing No. 4-0234-1004.

Q Is that in the short little volume here?

A Yes, sir and it is --

Q And under what tab is it?

A Behind the tab, "Location of Facilities". It is about the fifth or sixth page behind that tab and it is the only map.

MR. BAYLY: Mr. Commissioner, if I could interrupt at this point. We have done a quick canvassing and none of us have received that volume, although we have received the maps that I believe go with it from Arctic Gas and I am just wondering if we are going to receive that.

MR. GENEST: Of course, I am surprised that you have not.

MR. SCOTT: The difficulty, Mr. Commissioner, is that I gather that the revision was filed with the Minister. The Minister mailed it out apparently without consulting with his colleague, the operational head of the post office and as a result of that failure of communication it has not arrived in anybody's hands.

MR. GENEST: Well, Mr. Carter, is going to -- I think thatwe have some copies up-stairs and I will see that they are distributed this morning-- I appologize.

THE COMMISSIONER: Well, I take it then that I do not have it either.

MR. GENEST: Yes -- that is Exhibit 66. -- 67., and at least I have one copy for you.

MR. SCOTT: Mr. Genest, so that we will not all be in the dark, I take it that you have some other copies upstairs, have you?

MR. GENEST: Yes, we have some other copies upstairs. And why don't I pass this copy down the table. I will use Mr. Dau's copy.

Q Anyway, Mr. Dau, that is the same as the alignment sheet in the original volume --

MR. DAU:

A Yes, sir, except that it shows the Fort Simpson change. That is correct.

MR. GENEST: Well, why don't we all use -- until we get enough copies -- the

original one, and then we will talk about the Fort Simpson change a little later.

If you will all turn to Exhibit 54 which is Section 8 and 9 -- I am sorry, I am bogging you all down, Mr. Commissioner. There is map, a long pull out map under the tab "System map" and that shows the same information, except that it shows the route before we made the Fort Simpson amendment. So perhaps that will resolve the problem while Mr. Carter is digging up the copies.

Let's start again.

MR. DAU:

A I will ask Mr. Williams to mark off the description on the map on the wall as I go through the location.

The Richards Island supply line orginates at a location on the northside of Richards Island in the Mackenzie Delta. The direction follows a route in a southeasterly direction to a location called Travaillant Lake Junction near Travaillant Lake. A lateral line some 15 miles in length connects the producing area near Parsons Lake to the Richards Island supply line.

The supply line from Prudhoe Bay enters Canada on the Alaska/Yukon Border some 5miles south of the Beaufort Sea coast and follows a route in a southeasterly direction parallel to the coast and the Mackenzie Delta to an area near Fort McPherson and then proceeds easterly to the Travaillant Lake Junction. From this junction the route lies east

and generally parallel to the Mackenzie River to Fort Simpson. And in this case of course there is the revision at Fort Simpson. From Fort Simpson the system follows a route directly to Zama Lake in Alberta and then generally parallels the facilities of Alberta Gas Trunk Line, passing west of the town of Peace River and east of Edson to a location near Rocky Mountain House called Caroline Junction.

MR. GENEST: Excuse me, Mr. Dau, can we see that, if we turn to the map -- in volume, in exhibit 54, that is volume -- or that is Section 8, there is a map of North America there. Can we see that sort of illustrated on that map?

A It is illustrated on that map, but it is also shown on this pullout map.

Q That shows south of 60 does it not?

A Yes.

Q Of course, sorry. Proceed.

A From Caroline Junction one delivery lateral generally parallels the facilities of Alberta Gas Trunk Line and Alberta Natural Gas Company to Kingsgate on the B.C./Idaho Border. Another delivery lateral originates at Caroline Junction, again paralleling the facilities of Alberta Gas Trunkline to Empress on the Alberta/Saskatchewan BOrder and then proceeds directly to a point near Monchy, Saskatchewan, on the Saskatchewan/Montana Border.

Q I notice that the reporters have not got that -- that is --

A Monchy. M.O.N.C.H.Y.

Q Right.

A The map also, and I am referring to this map, shows the location of 49 compressor station sites, and indicates the operating year in which the stations will be required, as well as indicating the future stations that may be required under the gas throughput levels used for filing. The locations --

MR. GENEST: Can I just interrupt you there, Mr. Dau. I am just trying to find out the key to the legend and you have compressor stations -- for instance, I am looking near Fort Norman, M-09 (400) then 2 -- What does that tell us?

A M-09 is the number of the station.

Q Right.

A The 400 in the brackets is the mile post of the station. The 2 is the year in which it is required -- that is operating year --

Q Measured from what start point?

A Operating year one.

Q Operating year one. That is after you have built it, tested it and you have started to put gas through it?

A Yes, sir, and the black dots indicate that that particular station has

the chemical refrigeration to chill the gas and on this you go farther down the system and there are circles and also some locations which are the circles with half filled with black. The legend on the right hand side of the sheet describes what they are --

MR. GENEST: Mr. Anthony -- was there any trouble, Mr. Anthony?

MR. ANTHONY: No, I was just trying to get -- apparently there is confusion about the exhibit numbers. I just wanted to make sure that we have the right, proper exhibit numbers.

MR. GENEST:

Q Then you have some here showing the letters F.U.T. -- Foot --

MR. DAU:

A Those are future stations. They apply to the supply laterals and those are stations that would be required beyond the gas throughput levels in the filing.

Q Sorry, could you explain that a little more.

A Yes, if we go to the Prudhoe Bay lateral, the first station inside Canada is C.A. -05 at milepost 224. It is required in operating year 2 and it has mechanical refrigeration. It also happens to have a measuring station required in the year 2.

We go to the next station to C.A.-06 , milepost 270. It is required in

the future whenthe volume flowing through that lateral is in excess of 2 1/4 billion feet a day.

A   Continuing on, the locations of 8measuring stations are also shown, one near the Alaska-Yukon border, one at Richards Island, one at Parsons Lake. Those are the locations where natural gas enters the system, one near station M-27 on the Alberta-B.C. border, and at the Alberta-Saskatchewan border for delivery to other pipeline facilities.

Q   What is the purpose of measuring stations?

A   To measure the quantity of gas that either enters or leaves the system.

Q   What do you need them for?

A   It's a control of gas in the system. Q: It permits you to send a bill out.

A: Yes, there are also measuring stations at Kingsgate and Monchy where gas leaves the system.

Operating and maintenance of division headquarters are shown located at Inuvik and at Calgary, and district headquarters are shown located at Norman Wells, Fort Simpson and Peace River.

This particular map also shows the location of 45 stockpile sites.

Q   Where do those - - they are black triangles, are they?

A   Yes sir.

Q   And the white triangles are stockpile sites of wharves?

A   Yes.

Q These are stockpiles for what?

A Stockpiling pipe, preparation material and so on, required during construction.

Q Now that is the prime route we have described.

A Yes sir,

Q And you have also filed some details in connection with what we call the interior route, which I note is not shown on the map on the wall.

A I'm sure Mr. Williams can follow it through.

MR. GENEST: Q Would you describe -- perhaps, sir, we could arrange to mark that one, too, if none of my friends object. I could have one of my people take a black line and get a ladder and sometime mark the interior route as I'm sure we'll be discussing it at some length.

Would you describe that, Mr. Dau?

A Yes, the interior route was selected to pass south of the Arctic National Wildlife Range in Alaska. In this case the Prudhoe Bay supply lateral enters C anada on the Alaska/Yukon border some 20 miles northwest of the Village of Old Crow. The route proceeds easterly, passing south of the lake area known as Old Crow Flats, and north of the Porcupine River. The route crosses the Richardson Mountains near the headwaters of the Rat River in the Yukon, and the Barrier River in the Northwest

Territories. It continues eastward down Stony Creek Valley and joins the prime coastal route near the Peel River crossing about five miles north of Fort McPherson.

Q And then it follows it along to the junction point?

A Yes, that's right. It's right on the lake. This particular route involves very difficult construction in the Brooks Mountains in Alaska and the Richardson Mountains in Canada, and will cost several hundred millions dollars more than the prime coastal route.

Q And I take it you had reference to the Arctic National Wildlife Range in Alaska, and that is along that part of the coastal route which is within the borders of Alaska.

A Yes.

Q And that has caused some environmental concern.

A Yes sir.

Q The route, the interior route you described, I understand, is designed to avoid that range.

A That's correct.

Q Then, sir, may I ask you to describe the process of route selection?

THE COMMISSIONER: Excuse me, Mr. Genest, before you do that, will we be told at any stage how much greater the cost that the interior route would likely be than the cost of the prime route?

MR. GENEST: I think Mr. Dau

can give you that.

Q Do we have that detailed cost information?

A I don't have the details here, sir, but it's in excess of $500 million, if I remember correctly, some $550 million.

THE COMMISSIONER: That's the difference?

A That's the difference.

MR. GENEST: But I could certainly provide you with more detailed information, sir, if that becomes a matter of --

THE COMMISSIONER:Well, rounded off, it's half a billion, that sounds like it will do for now.

A I believe those compari-
MR. GENEST:
sons are -- when we deal with the alternative corridors I believe we can deal with -- in more detail with that, sir.

THE COMMISSIONER: I simply wanted to have that in mind.

MR. GENEST: Q Then, Mr. Dau, I'm going to ask you to describe the process of the way you go about selecting this route.

A The factors considered in the selection of the route are set forth in Section 8(a)(i) as revised, 8)a(i) to (viii).

Q That's the first tab?

A Yes sir.

Q There's a red tab called

"8(a), Facilities Location,"
and there's a pink tab called,
(i) Description."

A Yes.

Q And that's where that's discussed.

A Right. In general, the proposed route was determined after detailed study of maps and photomosaics, aerial and ground reconnaissance, and terrain and soil study. The final route selection shown on the aignment sheets involved consideration of the technical and economic feasibility of the various alternatives, together with environmental and sociological considerations.

The criteria which was established for route location, was as follows: With all factors being equal, the most economical pipeline route is the shortest distance between the source of supply and the point of delivery. From this base, adjustments were made to take into account the following:

(1) The proximity of the pipeline to other known and probable future sources of supply;

(2) Terrain barriers, including mountain ranges, lakes and rivers;

(3) Other topographic features, surface vegetatiion and land use;

(4) Soil characteristics and slope stability;

(5) Access for construction and future maintenance and operation;

(6) Consideration for wildlife incuding mammals, fish and birds;

(7) Proximity of large urban centres; and in this particular route there is no concern, of course, with large centres;

(8) In permafrost terrain (which is the main factor that makes this project different from other major pipeline projects) the avoidance of:

- Side hilllocations in high ice content fine-grained soils;
- Degradation of thermokarst areas;
- Unstable banks at river and stream crossings;
- And avoidance of areas of potential pipeline buoyancy.

Q Now pipeline buoyancy is when you have ground that makes it float, float up to the surface?

A Yes sir, the pipeline is buoyant in water, for instance, and it would float. It's necessary to put on weights to keep it submerged.

Q You want to try and avoid those areas if you can.

A Yes, where it's feasible to do so. In many areas it's not feasible to avoid it.

Q Well then, let's go through this step by step, Mr. Dau. How do you go about selecting a route?

A The initial map studies commenced in early 1969 when the sponsors of the project at that time decided to expand the study of

line from Fort Liard area of the Northwest Territories to consider deliveries from the Mackenzie Delta and Prudhoe Bay potential gas supply areas.

Alternative routes were considered from these points to the Trans-Canada Pipeline system near Brandon, Manitoba, and the Canadian-U.S. border crossing location near Emerson.

Q When you talk of map studies, what do you do, do you just take out detailed maps of the general area and look over the terrain?

A We get the best available maps and based on the information on the maps, attempt to locate the shortest route between the two points under consideration, considering the barriers that are obvious on the maps. In many cases these maps were--in some instances these maps were at a scale of 8 miles to an inch at that time.

Q Then what do you do?

A Once the map study was complete, the major alternative routes were flown by engineers experienced in pipeline location, using both helicopters and fixed wing aircraft. These reconnaissances trips deleted some of the alternatives and others were retained for further study.

Q Will you stop there? You first look at a map and you see from the map that there is a great mountain range here and you don't want to go there, so you pick out a general route that way. Do I understand that correctly?

A Yes, that map, for instance, may have 500 foot contra-intervals.

Q Yes.

A And on a 500-foot contra-interval in a map study you may conclude that it's a feasible route, but once you go look at the terrain you will find that the terrain is very undulating, very difficult, and that particular section would probably be deleted.

Q So your next step then is to look over, on the ground or from the air, fly over the route you've selected just from the map.

A Yes, with at that time considering construction difficulties access and so forth.

Q Where does that get you?

A That narrows down your alternatives so that you're then in a position to look at more definitive areas in much greater detail.

Q And is that the next step?

A That is the next step, sir.

Q And could you describe the next step, what you do then.

A We obtain two copies of the existing Canadian and U.S. Government aerial photography to cover the area under consideration. Dr. Mollard also obtained small scale photo mosaics at a scale of about 10 miles to 1 inch over the coastal and Interior Route areas and over the Mackenzie VAlley.

Q Let me stop you there again, Mr. Dau, excuse me. You have -- the first two steps, the general map study and the flying over, does that narrow you down to a certain area of ground? Or sort of corridor or a general route?

A It would narrow you down to probably alternative corridors and -- carefully -- corridors may be very wide in that sense.

Q Well, how wide?

A They could be 40 or 50 miles wide in that sense, before you literally go out fly it but once you have flown the route, they are much narrower of course.

Q Well, after you have flown the route, to what area have you boiled it down, generally?

A In a general sense probably within 10 or 15 miles.

Q And so you have got a corridor if we can call it that of about 10 or 15 miles wide, maybe wider in some areas, smaller in others.

A Yes

Q But that is the general perameter, if I can use that scientific word.

A Yes, sir. I might add that these small scale photo mosaics that Dr. Mollard obtained at this scale of 10 miles to the inch are -- cover an area which is really an overview of 100 to 150 miles in width. In other words it covers the whole valley, the whole coastal plain. We then had several meetings with Dr. Mollard to obtain the benefit of his knowledge, with particular respect to permafrost and potential terrain problems to be encountered over the northern portion of the route.

Q Excuse me again, Dr. Mollard got into the act, if I can call it that, after you had narrowed the route down to this general corridor 10 to 15 miles wide?

A Yes, sir, it was after --

Q After that --

A After the aircraft --

Q Right--

A Reconnaisance flight. In preparation for his analysis Dr. Mollard participated

in some of the early reconnaisance trips, you must understand that there were many of these reconnaisance trips to go back and investigate some of the alternatives that were available to us.

He then used one set of photography to identify terrain types in a band varying from a four to nine miles wide. The width of this band of terrain typing is dependent on the scale of the photography that is available.

Q So what did you want then from Dr. Mollard? You wanted to know more about the kind of terrain that was in that band?

A Yes, sir, we wanted to be able to anticipate what type of terrrain so we could assess it with respect to construction difficulties and operating difficulties and so on.

Q Well, then, Mr. Dau, I am going to ask you to illustrate all of this by reference to a specific section of the line and I understand that the one we picked is the one that app ears in -- what is the exhibit number -- Exhibit 62, which is the Alignment Sheets North of 60, and the sheet that I ask you to use is the sheet that is called 1 C 10200 - 1015, and that appears -- 1 C 10200 - 1015 and that is at the back of the book and before you do that, before you -- well, you go ahead your own way -- I am like Mr. Scott. I do want to have a little evidence though to help people to understand what it is these alignment sheets show. I notice that they are in duplicate.

One has green information on it and the other has black information on and I wanted you to explain the use to which both of these are put -- would you go ahead.

A The green information relates to environmental factors, the black is more on technical. This is a viewgraph of that particular alignment sheet. The numbers in the lower right hand corner 1 C - 0200-1015. The map inset in the corner identifies the location on a larger scale map of the area, and it is the little black triangle identifies this particular location of this particular alignment sheet which is on the west side of the Mackenzie Delta, west and a little south of Aklavik.

Q Right.

A The legends. This corner of the sheet lists --

Q That is the left hand corner, the bottom left hand corner?

A Right, sir,

Q Right.

A Has a legend of all the symbols that are used. This lists engineering data relating to the pipeline route which is shown in black on this alignment sheet.

Q Now, you are showing so that we have a record that makes some sense, Mr. Dau, when you say this, you are showing the material immediately above the pipeline legend on the bottom

lefthand corner.

A Yes, between that and the alignment sheet.

Q Right.

A The alignment itself. The pipeline routes is shown in black on the alignment sheet. The terrain typing, that was done by Dr. Mollard, is indicated by the white dash lines that enclose symbols, and if I could go to the top left hand corner of the sheet there is a dash line that has got M.R.D. -- M.R.D. --

Q Where is that M.R.D.? You are showing us what that means.

A Yes, M.R.D. -- I am sorry I cannot read them here, but you will find that it will describe that terrain type and M.R.D. is Mackenzie River Delta. Mackenzie River Delta.

There is another illustration on the -- on the other corner of the sheet, this is the lower righthand, there is a small dashed white line with a symbol B.R. B.R. can also be found in this legend and stands for Bedrock.

Q Right.

A The is the limit of the Delta, the M.R.D. terrain type. This is the channel in the Delta, Husky Channel. This is the Willow River. There are, at the top of this sheet, there are data relating to test holes that have been drilled in this area. The top of each one of these test holes

has a number, B 2520, for instance, and you can find that number on the aerial mosaic. That is the location of the test hole, this is the information that was obtained when that test hole was drilled.

Q Right.

Then there is a profile in-between that data and the alignment sheet itself, what is that?

A This is the profile of the pipeline route and in this particular instance I believe that it varies from about 25 feet to 175 feet. The scale is on the left hand side of the sheet.

Q That is above sea level?

A Yes, sir.

THE COMMISSIONER: Dr. Dau, you might have said this, but I was scanning through the documents and must have missed it. I take it that we are to turn that map by 90 degrees, I take it the pipeline is going north/south, in that map, is it?

A Yes, generally -- that is the north direction, sir.

MR. GENEST: North is at the left hand side.

THE COMMISSIONER: Yes, I thought it must be but you never know.

A These are long strips and we try to set the pipeline in the strip.

MR. GENEST: I might say,

Mr. Commissioner, that Mr. Dau is one of the few people around here, including Mr. Scott and I who is not a doctor, one of the last we will see.

Q I interrupted you really to ask about these alignment sheets. I then would like to ask you or perhaps Dr. Mollard to illustrate the work that he contributed, how he went about his work to assist you in the pipeline selection. Are you going to deal with that or is Dr. Mollard?

A I think that Dr. Mollard should deal with that.

Q Dr. Mollard, could you take over.

DR. MOLLARD:

A I shall carry on, shall I?

Mr. Commissioner, I have made some notes here on one piece of paper to just describe the procedure that I went through and I will just be referring to it briefly as I speak more or less extemporaneously.

My job, as has been pointed out, was to present terrain data in a way that would be helpful and useful to my client's personnel, including route location people, persons concerned with geotechnical studies and vegetation, and other studies, and the object was to try and identify the terrain and classify the terrain and map it so that it would be useful to these people that were doing the route location and appraisal of the information.

So really there are several components here. First of all you have to recognize what the terrain looks like, just like a photograph of a person which has features that identify them. Then once you think you can recognize it satisfactorily, then you have to classify it, because you have large areas which you're dealing with, that are classified according to a system that makes sense in terms of the use of the data; and then for my part, after I felt I could classify it I had to map it because several different people were going to use the map data.

Now you may ask, first of all what is terrain? How do I think of terrain? Well, I think of it more or less as landscape with a third dimension down into the ground. That is, when you look out of the window you see terrain, you see vegetation, you see rocks, soil, man's activities, lakes, swamps, and so on, so that it's appropriate, I think, that we think in terms of areas. It's a piece of ground for a particular use, and we say

it's wet ground, or you might say it's rocky ground, or gravelly ground, or terrain,which is more or less synonymous in that case with ground.

So that's briefly how I would visualize terrain. Several components, drainage, erosion, relief, what we call land forms, land forms are units,relief forms on the surface like a sand dune, for example, which is composed of sand about the size of sugar; or and I have an illustration, an esker which is a winding -- it looks like a railway gradient , sinuous and winding and composed of sand and gravel --

Q How do you spell that, doctor?

A E-S-K-E-R, and it's composed of sand and gravel, and as I say I'll show you an illustration, which is deposited in a river bed in the tunnel in dead ice or stagnant ice, because if the ice moved it would just spread the sand and gravel bed, which is about the width of a river, or a railway, across the landscape. So these are components of terrain that we look at and we look at them separately under terrain analysis and the interfacing or relation of one to another, so we come to the term "terrain analysis". What do we mean by "terrain analysis"? Well, I look at aerial photographs and try and figure out how the land is made, the composition of the land, the anatomy, you might say, of the land, and the component parts, and in that,my analysis, using aerial photographs and looking

down vertically from various heights, just as the camera in the plane looks down, some cases two miles, some cases seven miles, above the ground surface, and I look at these photographs in 3-D, simply with a little pocket stereoscope and this is the one that I use which costs $20, and the older I get the poor my eyes get and the more I have to bend the legs on it to see in 3-D, but this is what I use.

My professional work, of course, is in terrain analysis, and is not too terribly different from an amateur -- what you might call an amateur terrain analyst, for example, driving in from the airport here, you see a ski slope there. Well, a person standing at the top of that ski slope is doing terrain analysis in a way when he stands there and he looks down the slope and he says, "How steep is it? How narrow is the path that I have to go down there? Is that good going or poor going?"

If it were somebody like myself, I'd say, "How soft is the terrain at the bottom of the slope?" But that is sort of an amateur terrain analysis, and we do that when we stand on a mountain peak or a hillside looking down a slope. We're looking at the various units of terrain and we're saying, "How do they relate to one another, and what do they mean to me?"

Now in doing this work, I prefer to look at high level photographs, that's pictures taken from oh, 30 or 35,000 feet, six to seven miles, because I get a big picture of the land-

scape, and if I'm going to try and identify what's at a point, in other words if I put a -- take a pencil and put it down on the photograph and I say, "What's under that pencil? I want you to tell me."

This is what I do in class with students. "What is underneath that point?" If you want to get to that point, the easiest way is to look at that terrain from a high level first and then come down successively to lower levels because if you took me, for example, sitting here -- and I don't want to take anybody there -- and say, a square inch on the side of my face might mean very little, you couldn't identify me, it's too small an area; but if you stand back and look at a whole picture of me (and that's what we're doing with aerial photographs, we're dealing with pictures) and my orientation is identifying features in pictures somewhat as you would do with a picture of your grandmother but through the years I get to recognize the distinguishing features. So that's roughly how we go about it -- try to look at a high level photograph first and get a broad perspective of the terrain, and if I want to understand the Mackenzie Valley and the materials in the Mackenzie Valley, possibly the problems in the Mackenzie Valley, then I have to first of all get a framework of reference, so that I understand the geology and the processes that have gone on in the valley when they occurred because the landscape has a history just like a person, and it's Mother Earth, and if we are going to try to treat her gently

we've got to understand her, and that's part of this first process of looking at the high photograph, looking at the broad picture, and one of the first things as Mr. Dau mentioned when I got into -- Mr. Genest, when I got into the act -- was to try and take the whole Mackenzie Valley corridor and figure out the geology, where different kinds of terrain were, how they were formed, what the composition, how deep the muskeg was, where there was an old lake bed, where the sediments had come down vertically, maybe silt and clay in very fine particles and settled in 600 feet of water, that's a different kind of terrain from the terrain where the ice has gone along like a bulldozer and pushed material underneath the ice, and as Dr. Fyles said in his overview, it produces glacial till. It's shoved in under the ice, so we may have a mile or two or three of ice. That's a different material, has different properties than silt and clay that have filtered down through 3 or 400 feet of water, and then as the ice recedes, out of the valley it might block the valley temporarily so that as it's melting and there's a piece of ice sticking in, as there was say west of Fort Simpson, and another one at Great Bear depression, these blocks of ice are sitting in there and they're dams and they create a temporary lake, and one of my first studies in the framework in High Level photographs study and mosaic study was to find out where these lakes were, what the top level was, and where the major glacial rivers, that's rivers from the melting of the glaciers, came into the lake.

For example,the Liard carried a lot of sand and silt, the Nahanni and Ruth farther up. The Great Bear and the Mountain River, these are points where you have a different material because the river carrying sand and silt comes into that old lake. So this broad framework was one of the first things that I tried to establish so that I would have a confidence level in my subsequent looking at lower level photographs.

So in effect, in short what you're trying to do is try to understand the forest before you look at the individual trees, I guess.

That's one way of saying it.

Well, I think if I'm right, Mr. Dau, I started assisting and working on the project in 1969, and at that time we always try to get every bit of information, particularly government information and G.S.C. information which I think is wonderful, as far as I'm concerned, because I find it a great help; but we got the glacial map of Canada and that showed us where the ice moved. We were going to see it in High Level photographs right here and subsequently in the last couple of years we were going to see it in satelite imagery; but at that time we didn't have the satelite imagery, we had the mosaic. So we got the glacial map of Canada which showed us, in rather broad outline, the general advance of ice into the Mackenzie Valley, where it moved in, and perhaps where it sat and melted back, and there might be three or 400 feet of water against the ice into which these very fine sediments were deposited.

Then we got a map that showed the retreat of ice out of the valley, because we were interested in the history. We wanted to know, well, the ice occupied the Mackenzie Valley about 15,000 years ago, let's say, and then started retreat to the east, eastward, and it didn't do that uniformly, it melted faster in some places and slower in others, and we wanted to know this because we had to get down to specifics as soon as possible. Yes?

THE COMMISSIONER: Excuse me, you mean it was melting on the east side and it was not melting on the west, is that right?

A Well, there would probably be valley glaciers in the Mackenzie Mountains to the west, but I'm referring, Mr. Commissioner, to the huge continental ice sheet which started west of Hudson's Bay and spread out in a big row and migrated across us here at Yellowknife, and west to the Mackenzie Valley, so that the migration or flow of the ice, when it got thick enough it flowed westward into the Mackenzie Valley and down around these mountains and up the Mackenzie Valley. Then when it started to melt, it sort of melted backwards in the same direction to the the east that it had originally flowed, and so that it melted in an eastward -- general eastward direction and I don't know, maybe here at Yellowknife where we're sitting, the ice front was over us here about 10,000 years ago.

So those two maps we used, and then because we wanted to be more specific, we

ordered the topographic map Mr. Dau has mentioned, because we felt we could see level benches along the side of the valley and we thought, "Well now, if the top of that level bench comes up to 900 feet, and we can see where the ice could block off and give you a lake," it doesn't exist there now, of course, it's drained, but where it could have given us a lake, this gave us further evidence and confidence. So we wanted to figure out this glacial retreat history and the system of lakes in the valley, because then when we came down we had another tool to correlate with the direct looking at a photograph. In other words, we had some blood sample data in addition to the photograph of a person that we were looking at.

We also got the government vegetation maps, the best that were available at that time, on a quite small scale, and of course we rifled the National Atlas of Canada, every map that they had in there that pertained to the Mackenzie Valley, and as Mr. Dau has mentioned earlier, we ordered the one inch equals 10 mile mosaics, and at that time we also ordered the High Level photographs of a good substantial part of the valley which would be about one inch equals a mile, and that's a good starting place because if you come down too low and start interpreting, down to a wart on the side of your face, you're looking into the trees, but when you get up high you can see the geology and the trees are dwarfed so that in effect they look like grass. You see the relief, you don't see the vegetation, and

at that level we wanted to mask out the effect of the vegatation, we didn't want it to harm us in figuring out the geology.

Now I think I've covered in a rather general way most of the things that I wanted to leave with you and I think that I'll probably go to some slides and maybe I can drawn some examples in them that are familiar to you. There was one this morning when we were having coffee here, I looked out the window and I could see a nice polish, nice smooth whale-back polish on the rocks right across the window. You want to look at them when you go out at lunch. They're the same features that I have shown on one slide, except that instead of bedrock materials that we see out the window here, mine are soil materials, boulders and silt, sand and gravel, all mixed up, churned around and moved underneath the ice but they look in shape very much like the bedrock, scraped and abraided rock in front of the building here.

Now I've selected about 18 slides out of about 250 that I have on permafrost, including air photos and satellite imagery and ground photographs showing permafrost features and closeup of samples, and so if you'll bear with me, I'll put them on the screen and go through them and try and explain them as best I can what I see on them and that I think might be most helpful to you, Mr. Commissioner.

Q We've taken a leaf from Mr. Scott's book in the overview and I will arrange to have these slides reproduced and put in a book so that they can be on permanent exhibit at these hearings.

THE COMMISSIONER: Thank you.

DR. MOLLARD: I might say that I can feel a little bit for the people in the back of the room, because to me this looks very sharp and clear, but it's just like I was telling you, that, in recog nizing people you see them from a block away, they look very small and you can just barely,barely recognize them, and then when you get up and look at them from two or three feet away you can see the detail. So I have the advantage here of seeing a great deal of detail, a foot or two, that you may not be able to see, it may be sort of fuzzy in the back, I just don't know.

This is just a snapshot of one of the mosaics that we ordered when we ordered our first set of mosaics. One inch to ten miles. And this little bar down here shows a distance of one mile. Now I haven't measured this but if you were to guess, that's one mile, maybe this is ten miles and that's maybe twenty miles, so we're looking there, we're looking down at about two hundred square miles, I would say probably minimum, two hundred square miles of land surface. This is Point Separation, which comes into the Mackenzie Delta. And you'll see these very, very winding sinuous streams in here on this so-called estuarine delta. In other words, not too long ago, several thousands of years ago, the ocean was back here, and now this is built all the way

north of Inuvik up to Nanook and up to the Beaufort Sea. And this is what Mr. Dau mentioned this morning when he said M-R-D. This is the Mackenzie River Delta, and we have a short abbreviated description of that on the legend as he pointed out on the right, and we also have a much longer description of the kinds of materials and the vegetation and what we call the "stratigraphy" which is layering like a layer cake. It's peat or dead organic materials at the top, and then silt and so on. That's part of looking at the total components of the landscape. Now if you look down here, you can see rather very vaguely just a little bit of this evidence that we have out in the front here, where the ice has flowed down here like that, and sort of given you linear features very low ridges and the really swales on the surface, you can hardly see them. You can see the direction of ice movement.

Then back here the ice stagnated and you get a lot of ponds. These dark thaw ponds, where you have had melting out of ice, ground ice, in a sense,these are what we call, "kettle holes", they are pieces of glacier ice that melted out. And so you have a whole bunch of sort of, depressions here of different shapes and different sizes. To me, looking at them, quite different from thaw features.

Now, there's a great deal of information you can't see at this particular scale. For example , here right underneath the 's' in five miles is a little lake, and right inside that lake is a hill, which is about two hundred feet high, and it is

wooded. And that's what we call a "cave" which is simply a mound of sand and gravel built in contact with the ice. Now we look at that in our one to two thousand , and it is fairly easy to pick out. So, in short, there is a whole series of things that you can see in lower level that you can't see here, but this is good for the broad overview. Giving you a sort of definition of the boundaries of major changes in the landscape, major changes in the history, and the materials. Because ultimately we want to say, how was the material laid down, how was it made, when was it made, what are its properties, what do the properties mean to us in terms of our project? That's the name of the game.

Okay, now, that was a government mosaic that we purchased. And I confess that this isn't the greatest mosaic, but this was one we made ourselves. You can see the corner of the individual photographs, this is the photograph number down here, and we simply pasted these together. And where they are rather dark along here, this should be the same tone, if the photographs were tone matched, but unfortunately the old original photographs were fairly poor quality, and we could interpret them quite nicely, but for making a beautiful picture that looks like one single, instead of having a patchwork of several. That's what a mosaic is, you lay several photographs down, so that you are looking at a long length made up of many individual prints. And this is what Mr. Dau's window on his photomosaic is, only much more professionally done.

NOw, this shows the Old Crow Flats

here, and Old Crow down here, the Porcupine River, in what we call Pediments Slopes. These square shaped lakes up here in the Old Crow Flats, which are a very fascinating thing and have been reproduced in several technical journals. And the same legend, abbreviated legend on the right. We wanted a shorthand, we couldn't go into a great deal of detail, but we wanted a shorthand legend so that you can read it and look over here and know what kind of materials these are. Fine sands, silts, over clays, for example.

Now, that last picture was a mosaic made from prints taken from an aircraft flying at about 35,000 feet or 7 miles up in the air. This is the kind of mosaic we'd like to prepare where you don't see any lines, it looks beautiful, but really it's an Erts, it's a satellite image. That is, it's taken from the old satellite going around the earth and coming back to the same area every eighteen days and flying or orbiting the earth at 570 miles above. And giving a scale here of one inch equals 16 miles, so that this is the Great Bear River. I can't say that it's real sharp, but to me it's sort of fuzzy, but I can see the islands in the Mackenzie River here. I can see Mount Clark in the end of the McConnell Range. I can still see, even at this -- I'm going to step off here, before I hurt myself -- I can still see the direction of the ice. You see the ice came through here and moved in and blocked off the valley. This is high on the west side of the Mackenzie Valley, so the ice simply came in here moved over here blocked this off, and formed a lake back in

the south, toward Black Water, Saline, and those creeks and rivers coming in from the east. Then the ice came in here, blocked this off, gave us finer grained lake bottom material, quiet water, then as the ice receded out, you had a delta built in here of sands and silts. Sands just about the size of sugar, and when it dried up and the ice moved away, ten or fifteen thousand years ago, the wind came along and picked these grains of sand up in the air and blew them into dunes, sand dunes. You couldn't make a sand dune up there now at all but at that time the conditions were just right, like they are now in California and places in Southern Saskatchewan for building dunes.

Now, we'll look at one of these slides, in this little area in here at a lower level, and you can see an entirely different type of detail. So this is what we call a "band" -- let's see, "band six" which is in the near infra red. It's not even in the visible. This picture isn't taken in the rainbow which we see from violet to red, it's taken beyond the visual, in the infra red, photographed in infra red.

Okay --

MR. GENEST: May I ask, so what?

DR. MOLLARD: Well, yes, okay. May I say, hear, hear. You mean about the infra red?

Q Yes.

A Well, it really --

Q I have trouble enough understanding all this without throwing curves at me.

A Yes, well, shoot the curves.

The advantage of an infra red, and I had four and I picked this really because to me, it was a little clearer. But what the infra red does it highlights the drainage, where you have a water table near the surface, you have creeks, where you have ice breakup, in other words, if I am doing a study now in the North of ice-breakup in river, and I've ordered all of this same band that we looked at showing the ice-breakup in the rivers when it occurs, because it shows water black, and it shows ice and snow white. And of course it goes around and you get the same area every eighteen days, if you don't have cloud. So that is one of the advantages of the infra red. Shows your wet areas, and it also can accentuate the coniferous versus the deciduous vegetation.

Now, this is an area just south of Wrigley, and this is coming down from 700 -- what did I say, 570 miles -- down to about 7 miles. This is the kind of photograph that I like to look at early in the study, because as you can see here, this is all vegetated and this is quite heavily vegetated in here. Quite tall trees, but still they are massed, because you can imagine being seven miles up, the trees look like grass. I look at this in three dimensions. It stands up, the valleys go down, and the rivers or the hills stand up in the air. You can see here that there is a suggestion of where this ice moved into the valley here, opposite a river between two mountains. It came in around Willow Lake river, moved into the valley, down about to, about

and slightly beyond River Two Mountains, where it started to melt.

So here is another block in the valley, and between here and the last one I showed you is where we had a lake up to about 900 feet. Quite a bit of silt and clay deposited in it. Now, this is what we call a "panchromatic" or black and white photograph. And I suppose 99% of our work is done with black and white aerial photographs.

But the next shot is going to show this little area, if you look at this little gully coming in here, and these islands here, I'llshow you a colour infra red. What a colour infra red does for us, and there is only one flight line down the Mackenzie Valley, flying at about a scale of about one to fifty thousand, which is a little bigger than one inch to one mile scale. One flight line, but what it does, is that it shows the stress in vegetation. In other words, we don't what is stressing the vegetation, it might be high salt content, it might be very, very shallow distance to rock and the roots can't get into the rock, it might be the permafrost table, the roots can't get down into the ground because it's frozen, and that is stressing it. So the plants aren't vigorous, they're not healthy. So anything that stresses the vigour of the plants, in other words, you give the willows and the paper birch a little thicker zone, and the roots can go down and they respond and they come out pink, and we'll take a look at that in the next photograph.

You see here is a little thicker layer, it's thawed a little bit deeper, these are a little happier plants than these over here, because they can put the roots down. Now we come out in an island in here, and I don't know whether that's sharp there Lee? It looks a little fuzzy there. That's better.

You can see, you have the Mackenzie River. This is just south of Willow, or Wrigley. The river water has been flowing around here so the willows on these islands in the river are thawed and they are responding by giving you this tonal difference. We just had a narrow band, and the flight lines started about the Sans Sault site, and ended about the airport at Fort Simpson, so there is just one band down there. But we found them helpful ,because we were going along, and we'd say, "Well, the thaw depressions look different, north here, around, River between,or between Around Mountain, Mountain River. There possibly the permafrost is coming in, we're getting more permafrost along the little pond ." But now, we come down here around Hodson Creek and Willow, it looks as though the permafrost is melting out, and that the little lakes are getting larger. They're swelling rather than shrinking in size.

Q Excuse me, Dr. Mollard, do I take it then that what this shows you is that it gives you information of what you are likely to find underneath that surface?

A That is right in terms of permafrost, it is simply one more tool that is very inexpensive, that you can buy from the Government, at a very small expense for a bout a dollar a print. And they are high level, so you do not have to buy very many of them.

I will not go into this slide, but it simply shows the exercise in terms of stages. The black line is where I visualise the ice front and this is the exercise that I went through in time, in space, because we have to think in four dimensions. Where we are in space and in time and this is what I was doing here, trying to find the blue areas, which are the old lakes which are now drained, so that when we looked at the air photo, just like they say, "It's Tuesday, this must be Brussels", if we are between Black Water Creek and Wrigly and we are below elevation 900 we should be in this kind of material. That is what that exercise is about briefly, okay.

Q Right.

A This was a map, a very, very general map of the valley that I prepared where we have many, many different types. I simply show this in terms of five. Green being the bedrock -- green being the bedrock in here. The blue -- this is

the old lake bed over Old Crow, and the blue in here being these lake bottom, no lake there now, but these are ancient lake bottom material which are fairly heavy textured, we say heavy, they are fine, they are clay -- not too sticky, but they have got a little bit of stick. If it was raining you would say that they are muddy. Now, into that lake we are going to have fairly good-sized riv ers coming in which were fed by the lake here. I have got deltas, and these yellow areas are deltas of sand and silt and they are important to us because they tend to get, to have more ice because they are in this silt-sized, a very fine sand-size and they are more susceptible to growing thse ice lenses, so when there is a tear in the vegetative cover, a tree gets knocked over by the wind and the sun looks down and starts to melt, then you get a thermokarst, one of these thermokarst depressions developing and there we see it, it looks like Dutch cheese on an aerial photograph, so that this is part of the picture that we are trying to paint --

Q Do you mean swiss cheese?

A Well, swiss, did I say swiss?

Q You said Dutch.

A well, the one with holes in it -- maybe I should be corrected there.

Could I have the next slide please.

Q There is some things that

I know.

(LAUGHTER)

A This is the Mackenzie River and this is just south of Fort Norman and we are coming down now so that we have got a little lower look at the thing. The lakes look a little sharper, these are thermokarsts. This D.L. stands for, it is an old delta, so that we have a layer of this fine sand and one of the clues, you are always looking for clues as to what the material is, in other words, if I put my pointer down there and I say, what do I guess for starters that material is below the moss and peat cover there? What kind of material, if I took an auger and went down there four feet, what would I strike? What would I strike? Can I guess the kind of material? Well, if you have had a little bit of experience you can say yes, I can guess and I can guess quite accurately, because here we are just seeing this side -- you see, these are long sand dunes that run for miles in this direction, big things that show up very sharply and they are very obvious to the photo interpeter. But what are sand dunes? They are wind carried, deposited by the wind. The wind can only carry material between about a tenth and a half a millimeter, that is from a very, fine, fine salt to about a medium coarse sugar. That is the kind of material it carries, so if I have gravel here I could not build sand dunes from the wind. If I had ice laid material, like I told you, boulders and so

on, laid by the ice, I could not build it.

So this occurance of these materials tells me what I expect to find here and this is a little slide failure along the bank, so these are deltane deposits, silts and fine sands with thermokarst, these will thaw, these are not glacier ice areas where a chunk of glacier ice got buried and then melted out, these are actually permafrost bodies of ice that have melted out. Okay, I do not think that I have too many more here.

This comes back to the picture outside the door here, where you have these smooth ridges, they look like cigar shapes here and that is where the ice moved over and underneath the ice as it overrolled the soil, mixed it all up just like a big bulldozer, it sort of streamlined the surface and when I look at this I say, "That is not in a lake bed, that is shoved in by the ice. It has got a different moisture content, a different density, it has got a different permeability than your lake laden materials." So, it has different geotechnical properties.

Now, you can look outside and instead of soil you will see the same thing here on exposed bedrock. Now, over here you will remember that I said the abandoned railway grade where the ice moved into the empty valley and all of a sudden it stopped, melted. The sun came down and it started to retreat, but there was probably a crack in the

ice and down the water went into the crack and down along underneath the ice in a tunnel and formed this little, wiggly ridge here which is maybe ten to 20 feet high of sand and gravel, enclosed as it is in the ice, so it has ice around it and then when the ice melts away it collapses, so you get broken beds and of course if it is the spring of the year, there is a lot of flow, you get gravel. If it is in the wintertime, thre is not much flow so you get very fine materials, there is nothing forced to carry, We will take a look at what this would look like if we just took a great big cleaver and we hacked through that ridge, which is 20 feet high, what would we see, okay.

This is the kind of thing that we would see. See the gravel, probably the spring, larger flow, here is a bed of silt, in fact there it looks as though there is a little organic material, maybe there was a little growth there for a time, or maybe growth in the land, if there wa s vegetation growing on the top of the ice as there sometimes is and it is washed in, here gives you a little darker band, but you will notice that this queer mixed up mess and this odd shape, looks like a layer cake with a bit of a twist, it has collapsed, so that you have got to be very careful when you put a hole down and you are looking for gravel, and I suppose we tested over 500 of these over the years. ONe hole can be misleading, but if you have tested a few hundred you know the general range and the complexity of these materials. They are

fine for certain uses, but no self-respecting concrete contractor would ever look at one of these deposits and if he could get coarser and better,cleaner material.

Okay, that shows an esker. Now, this is rather interesting because it is not collusion. Mr. Dau presented the picture, if you remember the one he showed to explain the terrain typing. This is the same area and I sited this one in Regina, as I say, one of 18 out of 250 slides and I did not know which one -- or I did not even know the sheet that he was selecting, so, that is maybe mental telepathy, but I just want to take a minute on this because what you have here is a fan shaped deposit coming down the Mackenzie Valley.

Now, if you have looked at a lot of photographs in a lot of areas, most of your alluvial fans are sand and gravel. We call these "C" for coalescing alluvial fans. We use the first letter on each so that we can remember them fairly easily, but what has happened here is that you have very steep sided basining here, It is like a great big bowl, very steep rocks and they are soft rocks, they are silt stones and shales, that is compressed silt and compressed shale. These are 60 million years old, these rocks, but they are exposed in a harsh climate. It is cold and there is a lot of freezing and thawing and these steep slopes shed material down the slopes like this and then you get a run off in the spring and the rain washes all this material out and

where does it deposit it? It deposits it on a fan. And it has been doing that for thousands of years. What do we see on the surface? We see vegetation, so we get growth and decay. That gives us organic material. so, if we put a hole down there we would say this stuff is weathered here into fine materials. It is washed out here, as basically silt and some very fine sand, deposited along these stringers, it is growing up year after year, the old deposit, a hundred years ago is now buried and it had grass in it, sedges, so that decayed and we get organic silt and that is how we look at this.

Then we say, well, in this environment it has also got ice in it. So it is an ice rich organic silt. Now, you cannot tell from drilling really where these little bodies of ice are, because they are like raisins in a cake. You know there are a lot of them, you know generally the dimension, but it is like looking down on a cake pan with icing on it and you have got a toothpick and you say,"There are a lot of raisins in that cake", these are the bodies of ice, where are they? And is it important that we define everyone and the shape? The thing is to get an idea of whether there is little ice or a lot and whether it is rather randomly distributed and what kind of ice it is in the sub-surface. Okay.

Now, I will just take a very short time and this is the terrain legend that we have prepared on volume two. This has been supplanted

by a later one because of route additions and so on, but we were interested in the landform depositional environment, this is what I have been talking about, how it was deposited, this gives us the relief-- is it a ridge or a valley or a flat plain or a depression. Stratigraphy, this is layering: is there one layer over another. In other words, is there gravel over clay over sand and so on -- or is there peat over clay? These things have construction implications in terms of construction and maintenance. I cannot assess the implications too well. I can get a good idea what I think, but this is really a pipeliner's problem with a great deal of experience in pipeline: How do you design, how do you construct it, what are the problems, what are the costs and so I simply look at these things and map them and somebody else puts the implication from these pipeline investigations. Not only engineering, but environmental.

A Permafrost vegetation then I thought if I was going to do this I should have an aerial photograph in there so that you could look at it in 3-D, then test holes, whether we had two or three or 20, this is quite old, I suppose this slide is maybe four or five years old, but we went through the whole corridor doing this, anticipated engineering characteristics of drainage and then columnar profiles, what we visualize, the range of depth because anybody that's done an awful lot of drilling, especially in routes, you know that you can have a terrain type and it's got uniform properties but you put a hole down here maybe five feet and you go over here and maybe 500 feet, it's ten feet and so on, so there's a certain expected variability or a little rhythm to that terrain type so you have to capture it and that's what we tried to do in the profile.

O.K., so we wanted to say really a little more than this. We wanted to say, this was the one we were looking at, where we had the coalescing alluvial sand, low gradient sands, less than one degree coalescing icebergs, silty textured sands all over the Richardson Mountains and so on. The land form, how they were made, and I went through that.

Then specificity one or two feet over these organic and inorganic silt and silty, very fine sand. That's the bulk of the material in those bands. Then the permafrost, the zone, this

is off Roger Brown's permafrost of Canada mean annual temperature, active layer and so on, this material is from drilling and from records and old reports that we had and so on that we had to go by.

So here land form, decompositional environment topography and permafrost underlying, incidentally, its -- you see, this has got to cover an area, in other words you start at a location in the north and you go 50 miles or 100 miles south, so that you may go across a boundary, one of Roger Brown's boundaries onhis map, and continue and discontinues, so this means it's widespread, this means that there are isolated occurrences and these other says that there aren't any availble or very little. O.K.

Topography, the same thing, naturally those are finite, the small things are very, very small , vegetation is light density and so on. The aerial photo features the same engineering characteristics -- and slope stability and the general first look at the thing -- settlement, excavation type, drainage, classification.

This one shows the kinds of material, and I would say probably that's the minimum depth on this side, and this is the maximum depth and this is the peak cover /and this is the ground ice condition that one would expect to see if you went down the surface. Now notice there's quite a long range here so that most of your holes down 10 or 15 feet will

be in this material. If you look at the next one, I think the last slide -- can you get the next one -- it shows quite a significant range of peat. This is fairly thick peat over lake bed materials, old lake bottom materials, sand, silt. You'll see quite a range in this second layer and it's over a third. We have three different materials with different layers and when you're test-drilling you've got to be very careful visualizing what you're test-drilling is doing. You've got to understand your material as best you can because you can put in holes every 500 feet and think, "Boy, those are really closely placed, and I know what's there," and then put in a hole in between them and find something slightly differently. The thing is, is the difference significant in terms of what you're doing? Do you have to know precisely after it's at a certain stage, then it probably doesn't matter in terms of design.

O.K., that's the simplest -- I think that's my last one, isn't it? Yes.

Q Mr. Mollard, I take it then that this gives the pipeline engineer an accurate idea of the type of terrain he is likely to encounter along the band of terrain that he has selected, by the process explained earlier by Mr. Dau, he's narrowed it down by map studies and so on, flying over it, to a band of terrain. How do you -- I take it these are conclusions drawn from your study of the features and the process you've just described -- how do you test the veracity or the

accuracy of the inferences that you've drawn?
A Well, you put in a number of holes and test them. For example, in a sand dune I'd think twice about putting a hole in it, you know, the number I've seen because I've tested hundreds of them so if it is a cost thing you put them into terrain which is a little more variable and which you would expect a little more variation. But in this particular project, starting back, we had a whole series of holes and then later on we added to them and then latterly the Department of Public Works has put in something like 7000 holes so these were used to verify the terrain typing that I had done, and I think just looking back, I was looking at some yesterday morning in Calgary, where you know, you go from 800 holes to 7,000 or 8,000, and I can't say that my impression of the terrain units changed substantially with that increased drilling that was done. It was basically much the same.
Q So the data that you got confirmed that your typing was accurate.
A Well, I'd say I think it's acceptable from my standpoint. I think it's good. You see, I look at it as a person that's looked at many of these and tested many of them in the field and so on, and I want to derive a given level of accuracy that's useful and desired and necessary for the project.
Q Right.
A At a given stage, and

think this is, and that's how I look at it, because, you know, I've been on projects where we've done five or ten drilling programs lasting ten years, and you get more and more information; so at the stage and the intent of the job, what it was designed for, I think the level of accuracy is quite good and I think it matches the other maps of the Mackenzie Valley that I've seen prepared by other people quite well.

Q Mr. Dau, now how do you use that information that's provided by Dr. Mollard's methods in specifically route selection? I know it covers other matters as well, but how does it assist you in placing your route?

WITNESS DAU:

A Well, it is one of the many considerations used in selecting routes. The different terrain types and their characteristics, as Dr. Mollard has described, are assessed with respect to their construction difficulty or with respect to their performance after they have been disturbed due to construction, or with respect to the maintenance problems that may come up after the pipeline is built, and you can't eliminate all of the problems. You have to optimize your route. Maybe I can explain that.

Dr. Mollard may be able to, for instance, identify to us the areas in which muskeg was five feet deep on an average. He may be able to identify areas where muskeg is 20 feet deep. We would obviously prefer to be in a shallower muskeg if we have to cross muskeg. But that may add

significantly to the length of the pipeline. You have to balance the additional cost in going through the deep muskeg against the increased length of the route which is a cost by missing all the deep muskeg, and these have to be in balance.

Q I take it there are also environmental concerns --

A Yes.

Q -- and other concerns.

MR. SCOTT: I would prefer that the witness give the evidence.

THE COMMISSIONER: Well, I think that was assumed. I would be surprised if the witness 's answer had been "No."

MR. GENEST: I will bear that that objection in mind. I ;will try to be non-leading.

Q Would you then describe, Mr. Dau, how environmental and socio-economic consultants retained by the Arctic Gas Group and the Environmental Protection Board participated or contributed to the process of route selection?

A Yes, they were provided with maps and photomosaics of the route selected by the location engineers as a basis for their environmental studies. As both engineering and environmental studies were in progress, periodic meetings were held with representatives of both groups to discuss work progress and mutual concerns. In April, 1973, a week-long seminar was conducted, at which a mile by mile examination of the route as then proposed was made

by all parties concerned. The environmental and socio-economic groups suggested route modifications and commented on sensitive areas where special precautions would be required. After a discussion of the pros and cons by all individual groups, the route location was altered in many instances, to take into account special concerns and special construction and operation procedures were noted for other areas.

Q Does the present route reflect the modifications that were made as a result of comments and suggestions by these consultants?

A Yes, it does.

Q Would you tell us -- could you illustrate that?

A There were numerous modifications of the routing, the design and the construction schedule or construction plan. Many of these reflected the concerns of the vegetation and geotechnical advisors who were on the staff of Northern Engineering, and with whom the engineers had almost daily contact. Major modifications,together with the manner in which environmental and socio-economic factors received consideration are set forth in Section 8(a)(i) on pages 427, and Section 14(d), chapters 1 and 6, and 14(e) -- and this one with respect to the interior route alternative, of the material that has been filed.

Q Well, they are there and I won't take you over them. We would just be repeating them by reading them out loud.

A Yes.

Many minor changes were made to satisfy concerns that were expressed on bank and slope stabilities, creek and gulley crossings and thermokarst areas.

Q You have some examples, do you?

A Yes, referring to alignment sheets, the first alignment sheets is 1C -0200 - 1003. On this particular alignment sheet the route was relocated in two locations.

Q Do we need to look at the alignment sheet to get the message, Mr. Dau?

A The second example I am referring to happens to be the one that I used on the slide if that would --

Q Let's just have what you did with the first one -- that 1003,without looking at it , tell us what happened.

A There was a change made to avoid a poor gully crossing. The total route relocation was 3.3 miles long and it added no significant length to the route.

The second change was to avoid slumping ice wedge polygons on the banks of the Malcolm River and it was about 8 and a half miles long and added about 500 feet to the line length.

The second alignment sheet I am using as an example, as the one that we had previously which is 1C - 0200 - 1015, and the

pipeline route there was altered to avoid some poor bank conditions on the Willow River and I have pointed out the location of the WIllow River. This change is about 1.3 miles in length and in this particular instance, it shortened the line by about 100 feet.

THE COMMISSIONER: Excuse me, Mr. Dau, I am looking at that alignment sheet and is the earlier route the route that was altered after consultation with the environmental advisors. Is the earlier route marked?

A No, sir, it is not.

MR. GENEST: Perhaps we can illustrate that on Mr. Dau's slide.

A I think Mr. Watson is more familiar with this. He could probably indicate the exact change that was made.

MR. WATSON:

A First of all I might say that this was not totally an environmental concern. The environmental concerns that Mr. Dau mentioned earlier were listed in the exhibit 8 (a). These are a couple of examples of group changes that were made, but not specific environmental concerns -- they were mainly geotechnical concerns and this particular instance it was a very minor route change The original routing across the -- a little bit further down, after we --

Q You are indicating to the west of the black line that is --

A I am indicating to the west of the black line.

Q What distance?

A Well, probably in the neighbourhood of five to six hundred feet. You will notice from the profile here there is a bank that we run down from this ridge of knoll / marine surface down into the bed of the river itself.

Q Could you speak up a little -- I am sorry, -- speak into the microphone --

A Yes.

Our alignment prior to making this minor route change in this instance, was about where I am showing it here, west of our present alignment. From the profile you will note we dropped down from this ridge and knoll marine here down into the bed of the river. This slight readjustment gave us a bit of a better access to the river bed and it is also a bit better crossing and as it actually shortened the line by a little bit it is pretty obvious we should have been there in the first place and this came from studying the route after the preliminary alignment was done on it and we are continuing to do this and probably as more information becomes available, we will be making more minor corrections like this.

THE COMMISSIONER: WEll, I do not want to belabour this, but was there any specific reason for making that change other than it shortened the line?

A Yes, the crossing of

the Willow Lake River is slightly better where it is located then where we had located it in our previous alignment.

Q Why is it better?

A There is a bit of localized bank instability where our initial line was.

MR. GENEST: These, sir, were given as examples of minor changes made to satisfy concerns on bank and slope stabilities. The major examples are -- as to environmental and socio-economic factors are those listed in the application. Perhaps I could -- I said I would skip over -- but perhaps for the benefit of those here, those here who are not familiar with the contents of the application, I might go to those. The application materials list instances where modifications were made to avoid fish breeding grounds and so on. Could I deal with those or --?

THE COMMISSIONER: You suit yourself. You might give us one or two examples. I -- this is a public hearing and it is not just for the benefit of counsel and myself, but those members of the public attending as well. I -- forgive me for asking all of these questions, I just want to understand these things when we are looking at them --

MR. DAU:

A We have the other example that I mentioned. We have it on a slide if you

would like to see that , sir.

THE COMMISSIONER: Yes, please.

A This is alignment sheet 1C - 0200 - 1003. That is the one that I previously referred to, and the location at the Malcolm River.

MR. GENEST:

Q Where is that in the book, can we find it in the book, Mr. Scott? Have you got it?

MR. WATSON:

A Well, this alignment sheet-- we made a --

MR. GENEST: Just a moment, it is just twelve pages from the previous one we were all looking at.

MR. SCOTT: Why doesn't this book have page numbers?

All right, we have it, thank you.

MR. GENEST: The numbers are in the right hand corner.

A All right, we made two route realignments on this particular sheet as a result of geotechnical review. The first one was in this small gully, here.

Our previous routing crossed very --

Q You are indicating the mozaic at the left hand edge of the page --

A This is the left hand edge of the page --

Q Right --

A Our previous alignment passed slightly to the south of where the present alignment is shown. There is again an instance of eroding gully banks on this small gully here. We have made a slight readjustment to the routing which kind of got around that problem?

Q You moved it to -- on that one, the top of the page is north? Is it?

A That is correct.

Q And you moved the pipeline to the north to avoid the bank?

A Right.

That did not add any appreciable length to the pipeline route.

Q Well, then let me go back to the -- Oh, is there another change on that? I am sorry.

THE COMMISSIONER: Excuse me, before you proceed, you said move the pipeline to the north-- have I missed something here?

MR. DAU: This happens to be along the coast, sir. This is farther west.

MR. WATSON:

A This particular sheet is located on the north slope here, just about 30 miles from the Alaska/Yukon Border.

MR. GENEST:

Q Well, Mr. Dau, could I -- I think, are we -- oh, no -- you are going to illustrate --

MR. DAU:

A There is one more if I could just quickly mention this other change. This is the Malcolm River along here and our original routing in this area came down in this general area past to the south. Subsequent investigation after we had located the route there indicated that there are slumping ice wedge polygons on the bank of the Malcolm River in this area.

Q That is to the south of the present line as indicated.

A That is correct.

So the line was rerouted to the north of that feature. THis added about 500 feet to the line.

Q All right.

A THis sheet also shows a compressor station which is located immediately on the right bank of the Malcolm River. In this instance the ideal location for the station would have been in the middle of the river, but that is not really a good place to have it so it was moved to the right bank.

Q When you say "ideal" you mean from a --

A THis is from a hydraulic gradient --

Q Right.

Well, then can we turn off that machine and I would like to go back to the statement by Mr. Dau and ask Mr. Dau, you said that some major modifications brought about by environmental or socio-economic factors were mad e to the line and these are set out in Sectgin 8 (a) 1, pages 4 to 7 of the application, Section 14 D, chapters 1 and 6 and then in Section 14 (e) with respect to the interior route alternative -, could you highlight these for us, please?

They are summarized on Appendix "A" . I think the major one, of course, is the --

Q Appendix "A" of what?

A This is 8(A) (i) of the appendix of Section 8(a) description, it's on page 8.

Q Page 8?

A Right. The major one here, of course, is the major revisions that were made in the Travaillant Lake area as a result of environmental concerns.

Q Did Mr. Williams point that out where that is on the map? Although I think we all know where Travaillant Lake is by now. Got your pool cue, Mr. --

A The original routing crossed areas of high productivity for mammal, fish and birds. The change is to the -- it was proposed that a change of routing to the east or west be examined to find something that was much better. The Travaillant Lake junction was re-located 15 miles to the south-west.

Q So originally it was to the north-east of where it's shown, that was the original plan, was it?

A Right.

Q And the concerns of the environmentalists about -- how that would have affected the animal life, do you recall?

A I don't recall the

specific details.

WITNESS WATSON: I think the main concernwas located at a number of lakes, particularly where Mr. Williams is pointing there, to the north and west of Travaillant lake, and the line passed through these, it was just a question of the proximity of the pipeline maybe having an adverse affect and it was felt that if the line was moved out a bit,out of that high productivity area it would benefit.

WITNESS DAU: The line section from Campbell Lake was located about 20 miles west of the original route and also from Travaillant Lake junction to Thunder River crossing there would be re-location involved as much as seven miles of movement. In addition, the Mackenzie River crossing north of Arctic Red River was moved several miles downstream because of an environmental concern. In this area it was to avoid rare and endangered species nesting area.

MR. SCOTT: Mr. Commissioner, perhaps it wouldn't be out of order to ask Mr. Genest as he has highlighted that, when and if the cross-over is filed, that they remind us again of the effect of a cross-delta route on that particular section?

MR. GENEST: That's right. I have not proposed to deal with this panel, with the cross-delta route. What I hope to be able to file very soon -- and I hope to be in a position to tell

the Inquiry in a few days as to when exactly but very soon, a full set of materials with respect to cross-delta, and I felt -- and I hope you agree, sir -- that to deal with it now, without all the backup information would be a repetitious exercise. We have to go all into it again when we have the materials at hand. So I've deliberately stayed away from that so if my friends and Commission counsel can all have an opportunity to -- and of course their advisors-- give them an opportunity of looking into that, I thought it would be much more organized if we looked at that separately and everybody was armed with the materials necessary to look at it. But I certainly note Mr. Scott's comments.

MR. SCOTT: Well, Mr. Commissioner, I am entirely satisfied with that, but this is put forward as an example of an environmental modification that has been made in the event that the cross-delta route leads to the cancellation of that environmental modification. I wouldn't want anybody to be misled and perhaps when we get to that Mr. Genest will simply have in mind that he should refer back to this environmental concern.

MR GENEST: Sir, I'm not following Mr. Scott.

MR. SCOTT: I will tell you later.

MR. GENEST: Get me out in the hall.

THE COMMISSIONER: Well, just a couple of things. This panel will deal with

the change in the route of which we were advised some months ago --

MR. GENEST: At Fort Simpson.

THE COMMISSIONER: At Fort Stimpson.

MR. GENEST: Yes sir.

THE COMMISSIONER: Well, have you another panel on the proposed change?

MR. GENEST: Oh yes,sir. There will be a full panel probably consisting of many of the same people, but I thought that without the materials at hand, it was idle to pursue that subject. We'd just have to start it all over again.

THE COMMISSIONER: Counsel might bear that in mind, that if there are any second thoughts about that, we'd better hear about them early tomorrow morning.

MR. ANTHONY: Mr. Commissioner, may I ask just one question? I think this bears on the point Mr. Scott was raising. Do I understand correctly that there is going to be a cross-delta route proposal put forward, but you don't propose discussing it now?

MR. GENEST: Yes, I have to give to this Inquiry, to the participants, full materials about the cross-delta alternative. The studies are being put together now. We are, I think and I can only say "I think" at this moment, that we will be asking the Inquiry to look at it as an alternative, as a feasible alternative. We have

still some concerns to be answered on the cross-delta route, but we certainly want and would like it studied by this Inquiry and have our witnesses cross-examined on it.

MR. ANTHONY: I'd like to clarify in my own mind at that time, which we anticipate will be a fairly short period of time, that people such as Mr. Dau and Mr. Mollard will be discussing the use of the techniques that we heard about this morning as it relates to the other route?

MR. GENEST: Yes, yes, and I should say we are going into situations, I think you anticipated them in your ruling, sir, that we're going to have to call people back, we realize that, and we intend to be co-operative to the limit of our ability. All these people are available, and they'll be back.

THE COMMISSIONER: Yes, I think we all appreciate that. Just before we leave this cross-delta route, while Mr. Williams is at the board, Dr. Williams, can you just trace --

WITNESS WILLIAMS: Mr. Williams, an endangered species.

THE COMMISSIONER: -- can you just trace the cross-delta route for our benefit, just come along, if you would come along the prime route and just point out where you leave the prime route to go across the delta.

A O.K., the mike is on now. The prime route, of course, with respect to

the Canadian portion, originates at the Alaska-Yukon border and through there throughout this area it would not change until we get down to the Shingle Point area, at which it would break northward from the prime route, roughly here with a 4 1/2 mile crossing of Shallow Bay, on across the southern end of Langley Island, across several channels of the Mackenzie onto Richards Island at approximately this location. Then the intent would be to alter the supply leg from the Mackenzie Delta, using the same origin, coming down the west side of Richards Island to a junction point about here, with the Prudhoe Bay supply line continuing to this same junction of the Parsons Lake supply line, and following the same route to -- past Inuvik, approximately here, and then taking a more direct route to the east side of Travaillant Lake to join the originally filed prime route at about Thunder River. That, of course, would eliminate the section of the route to the west side of the delta, past Fort MCPherson, Arctic Red, and so forth.

MR. ANTHONY: Mr. Commissioner, may I make a request that Mr. -- when Mr. Genest's assistant this evening arrives with ladder and pen to put in the interior route, perhaps he could also put in the cross-delta route so we have the various information for us.

MR. GENEST: Yes, we will do that.

THE COMMISSIONER: Yes, just one other question, and I'm not anticipating the

whole thing, but is it fair to say, Mr. Gen est, that you don't have to answer if you don't wish to, but is it fair to say that cross-delta route is not one that would be appropriate if you were required to proceed from Prudhoe Bay by the interior route?

MR. GENEST: I think that's fair to say.

Q You were on Appendix "A", Mr. Dau. These are set out as examples of pipe-line route relocations. Did you want to comment on any of others?

A The others are not as major as Travaillant Lake. They involve movement of land relocations of up to one mile to avoid the en-vironmentally sensitive areas. They are just examples of that.

Q Now I take it that since you had a number of disciplines involved in this You received many suggestions.

A Yes sir.

Q Was it possible to accommodate all of the groups -- the biologists, the environmentalists, the engineers?

A No, that was not practical in all cases. In some instances we adopted the route location represented a compromise. Examples of this are:

(1) Along the north slope of Alaska and the Yukon Territory, the group concerned with bird life wanted the line set back as far as possible from the coastline. The people concerned with animal life -- caribou in particular -- wanted to see the route away from the mountains and foothill ranges and towards the coastline. In this instance the middle ground between these two features was selected, where possible.

Another example, along the east side of the Mackenzie River, the bird consultants would have

preferred the line set back from the river, whereas the fish consultants preferred a route closer to the river and away from the headwaters of the tributary streams. In general, again the middle ground was selected.

The only major area where all environmental disciplines have strong reservations with respect to routing is along the Canning River on the interior route alternative in Alaska. This is particularly opposed by the fish and animal groups, and to a lesser extent by the bird group who have concern for the rare and endangered species inhabiting the valley. Later in our testimony we will deal with the methods to be employed to alleviate environmental and socio-economic concerns by methods other than route selection.

Q That, I take it, is going to be in your construction?

A Yes, it involves construction scheduling later on.

Q I'd like to move on now to the Fort Simpson revision, and perhaps we could get Mr. Williams service again, well, we know where the original route is, to describe what the changes are.

A Well, I'll give you a little background first. In selecting the route and river crossing locations as originally filed, we examined routes east and west of Fort Simpson. At that time we selected a route west of Fort Simpson on the basis that:

(1) The route was shorter than the east of Simpson alternative by some two to four miles, depending on the refinements selected on each;

(2) The route crosses less muskeg terrain south of the Liard river crossing;

In balance, after taking into account the shorter length, the two river crossings and the muskeg terrain, the route selected was less expensive both in capital and operating costs, and that is the route west of Simpson.

Finally, we could find no significant environmental or socio-economic advantages to either route as compared to the other.

In our continuing studies we have, however, concluded that one change in design would be desirable; that twin pipelines should be installed at certain of the more critical river crossings. Such a change, twin or dual crossings of the Mackenzie River west of Fort Simpson, increases the cost of that routing alternative significantly, and in balance shifts the cost comparison to slightly favor the east of Simpson alternative -- even after allowing for the dual crossing of the Mackenzie east of Fort Simpson.

Q What's the reason that you concluded that you should have twin pipelines at major crossings?

A We do not expect to have failures in river crossings. We think the possibility of that is almost zero. However, the

consequence of having a failure at a river crossing at exactly the wrong time of year, which would be in freezeup or breakup, would be that the line would be out of service for one or two months or more. That consequence is so expensive, so great, that dual river crossings have been selected and they are --

Q As an insurance --

A -- as an insurance policy.

Q Sorry, I interrupted you.

A Well, the east of Simpson routing has the additional advantage of avoiding a crossing of the Liard River.

We have therefore concluded that the change should be made to the more easterly crossing. The new routing as described in the revised exhibit departs from the original route, near MP 583, and follows a roughly direct line to the Mackenzie River crossing about six miles upstream of Fort Simpson. From this crossing the new route proceeds almost directly on course to rejoin the earlier route in Northern Alberta near MP 860.

Q That's already shown on the map on the wall. -- the change --

A Yes sir. Its total length would be slightly more than that on the original route.

THE COMMISSIONER: Excuse me, how many dual pipeline crossings will there be?

A On the prime route there's a dual crossing at the Peel River crossing, at the Mackenzie crossing at Point Separation, at the Mackenzie crossing at Swimming Point, and at the Mackenzie crossing at Fort Simpson.

MR. GENEST: Mr. Dau, I want to direct your attention now to the report of the pipeline Application Assessment Group and perhaps to preface my question I could do it this way, that the group has expressed a number of concerns throughout the report which may be said to bear indirectly on the route selected. I want to ask you to comment only on those which relate directly to the engineering aspects of route selection, and I have specific reference, I think the most specific one was made in connection with terrain analysis and that appears at page 183 of the report. Was the report prepared before or after you filed your responses? What is your understanding?

A We filed our responses and then we got copies of the report after the responses.

MR. GENEST: I think it's common ground, isn't it, Mr. Scott, that -- I believe it says so in the report -- that they hadn't had the benefit of our responses when the report was issued?

MR. SCOTT: Hadn't had your responses.

MR. GENEST: Didn't give an

inch. At page 183 there is some criticism of the degree of detail, the lack of detail of terrain information, in your exhibit. Do you have any comment on that?

A Yes, we think we have responded to some of these concerns in answers to questions 13 in the response, to a minor degree in question 13; and also question 17 in respect to location of facilities and terrain analysis. We'd like to stress and we believe that the data attained from the terrain analysis performed to date is entirely adequate for route location at this stage. Terrain analysis is only one of the many considerations used in route selection. River and stream crossings, slopes, drainage, the lengths of the individual land sections, wildlife considerations, and construction difficulties and costs are also very important in the final route selection.

Q There's another concern, I think, raised at 8.5 -- Section 8.5 of the outline Assessment Group Report in connection with slope stability and erosion susceptibility. I always put the accent on the wrong syllable.

A Yes, they suggest that some potential failures could be avoided by re-assessment of location of the pipeline on access roads, particularly at valley crossings. We agree and have said so in quite a number of the responses for this request for additional information. It's spread over many of the questions and responses.

Q Do you agree that they will have to be a reassessment made?

A Yes sir, in the final design and final field investigations.

Q Do you have any other comments? There was another one, I believe, at Section 8.8.

A This was with respect to the impact on valleys. Specifically on page 217 there was a reference to the Thunder River crossing and the Great Bear River crossing. The response to question 35 provided preliminary design details and a crossing profile for the Thunder River crossing. We are confident that a safe, secure pipeline can be located at this location.

With respect to Great Bear crossing, we currently have a field investigation program underway on an alternative Great Bear crossing. If that field program is unsuccessful in locating a better crossing, we are confident that we can locate or we can design and install a safe, secure pipeline at the locations shown on the alignment sheet. This will require some special designsto handle problems of erosion and slope stability and so on and a later panel will deal with those particular design measures.

Q That is Dr. Clark's panel, I believe.

A Yes, sir.

THE COMMISSIONER: The Bear River is not a dual pipe crossing, I take it?

A No, sir.

MR. GENEST;

Q Then in Section 8, 13 of the report, page 252, some concerns were raised as to the construction of pipeline facilities and roads. What were these concerns? I read them

yesterday, Mr. Dau, and I seem to have forgotten --

MR. DAU:

A The response to question 16 -- discusses in considerable detail the limits to which compressor stations can be moved. There is a suggestion here that some of them should be moved some distance and there are some limitations that become hydraulically unbalanced if they are moved too far and --

Q Can you explain that a little bit -- it is something that my grandmother would have trouble with. How do you become hydraulically unbalanced?

A Can I dig up Question 16 first?

Question 16 discusses firstly an ideal pipeline which has no changes in elevation and on this, this is assuming a dead level terrain.

On this theoretical, ideal pipeline, relocating one station upstream from its hydraulically balanced location, in other words the precise location that it should be to be most efficient, if we move it upstream by half a mile it affects the total throughput of the system by about 0.2%.

Q Let's go back there, Let's go back to the fundamentals. A compressor station -- which before I started this case I did not even know you needed -- is there to add -- to keep the gas moving, do I understand that correctly?

A Yes, as the gas flows down the pipeline it expands and as its pressure is reduced the compressor station recompresses the gas up to the design limit.

Q And you need a number of them to keep pushing the gas through the pipeline-- am I right so far?

A Yes, it is very similar to a pump on a liquid system.

Q You do not mind my leading, do you, Mr. Scott?

MR. SCOTT: No, anything that will aid your comprehension.

MR. GENEST: And there is a point at which these pipelines must be located to fulfill their function, --

A These stations, yes, sir.

Q And is that what you mean by hydraulic balance?

A Yes, sir. Theoretically precise location by going through all the mathematice and saying, "I need a station at milepost 816.72."

Q And you do that by applying the laws of physics?

A Yes, sir.

Q So -- I interrupted you.

A Well, this particular response says that if you move it upstream by a half

a mile you lose .2% in throughput, downstream about half a mile .07 in throughput. Unfortunately this is not an ideal pipeline and we do have terrain relief and because of the terrain relief the stations can -- are not equally spaced, in other words, they are all not precisely 50 miles apart. If in fact the terrain is -- if we are essentially going down hill, the station spacing tends to spread out. They may be 55 miles apart if we are going down a hill, a long hill. If we are going up a hill they become closer.

Now, when the slope of the hill approaches the slope of the pressure drop in the system, the station can be moved considerable distances without much penalty, but in the converse case, if you are going up a hill your limits are very narrow.

We have some limits in moving stations -- you know, we cannot move them many miles without suffering a large penalty in throughput. We can suffer penalties by putting in more horse-power.At some of the stations we could move them, but that is also suffer ing a penalty in economics and cost and so on.

Q what is a major move, what is a minor move?

A A half a mile we can live with in most locations. Beyond that we get concerned.

Q Right.

A Lateral movements have no effect of course.

Q So it has got to be close to your pipeline?

A Yes, sir.

This particular section of course was also raised, concerned about -- concerns about other locations -- other facilities, I am sorry; the locations as shown on the application are based on information available from terrain anaysis, air photo study and reconnaissance. I am confident that detailed field investigation and detailed design will probably result in minor relocations of some of the facilities. But this is in a later, final design stage when there is a lot more field information available to us.

Q There is another concern expressed, and I am almost through, sir. Do you want to go on or adjourn -- I see that we have reached the witching hour -- I can -- I will finish this panel in another five minutes.

THE COMMISSIONER: Well, certainly, let's carry on then.

MR. GENEST:

Q Section 10.2 of the report -- that is the Pipeline Assessment Group Report, discusses pipeline and highway interaction --

A yes, sir.

Q And that appears at page 348 to 356 of the report.

A Yes, this section discusses the advantages and disadvantages of close spacing of the highway and the pipeline and as I read it, although no firm conclusions are drawn, it appears that the case for wider separation is stronger than for close separation. We agree with that.

Once the highway location is finalized and at the present moment that is not the case -- there are changes coming up all of the time and when the results of detailed field investigation of the pipeline route are available, again we are confident that minor relocations of the pipeline route will be required.

The number of pipeline crossings of the highway should be minimized as much as possible and parallel spacings of something less than a thousand feet should also be minimized. That does not mean that we can always maintain a thousand feet spacing. There will be areas where closer spacing will be required due to terrain, some side slopes, lakes, mountains and so forth. This is the Mackenzie Highway, of course, that I am referring to.

Q Now, we have not dealt with all of them, throughout your replies and I think throughout the requests for supplementary information by the Assessment Group, there is an acknowledgement that there is a final design stage at which some of these questions can only be answered -- or at which some of the concerns raised must be

settled. Could you comment on that, Mr. Dau?

A No, I just agree that some of these concerns can only be answered in the final design phase. We have got detailed field investigations underway. I am very confident though that the combination of minor route locations and special designs and when we are into the detailed design phase that we can solve these concerns.

MR. GENEST: Q With the final design phase, that would only be undertaken after the Minister has granted the right-of-way and the National Energy Board has granted a certificate of public convenience and necessity?

A Yes, essentially yes, because it obviously involves a lot of office time, drilling programs. They're very precise and things like that are very expensive programs, involve an awful lot of field work.

Q Well, did you have a ball park figure, Mr. Dau, as to what it would cost an engineer to fully engineer the pipeline beyond the stage to which you've progressed?

A Yes, several hundreds of millions of dollars.

Q And until you have a certificate, how do you consider that price tag?

A I think --

Q Is it justified or not justified?

A It's not justified, sir. No.

Q And in any event, what, I suppose -- well, that's a matter for argument. These hearings may have some influence on locations picked for the gas pipeline and on final designs which we would have to scratch and start over again. Would that be correct, Mr. Dau?

A Yes sir.

Q You would cross the river at point "A" and as a result of these hearings or the N.E.B. hearings you had to cross the river at an entirely other point, what would happen and what would be the value of your final design study at point "A"?

A It would have very limited value, it wouldn't be totally lost but I mean, any information you gain is of value to you but certainly you'd have to duplicate it at another location.

Q Right. Finally, sir, may I ask you in your professional opinion whether the prime route you've described is feasible?

A Yes, it is. In my opinion it's appropriate, efficient, and a feasible route.

Q And could I ask you the same question as to the interior route which you already said you consider less preferable?

A It's not as efficient, and it results in a higher cost, more difficult construction, and more difficult operation. It is feasible.

MR. GENEST: Those are all the questions I have, Mr. Commissioner, of this panel.

THE COMMISSIONER: Have counsel agreed on the order of cross-examination?

MR. SCOTT: Mr. Commissioner, I think the order of cross-examination, has been stipulated before, if not in a ruling, in a consensus agreed by

counsel. I will discuss it with them privately, if I may, just so it will be clear that there is no doubt about it. That presumably will not begin until tomorrow morning.

Mr. Bayly, however, indicated to me that he had one or two matters that he wanted to raise with you as opposed to the panel. If that could perhaps be done before we finish today?

THE COMMISSIONER: Yes, certainly. Just before you do that, this cross-delta route, Arctic Gas sent a drawing of the cross-delta route to the Inquiry and I've taken the liberty of examining it and would you, Mr. Genest, perhaps in collaboration with Mr. Ballem, prepare by the time we reach the cross-delta route presentation, prepare some kind of a drawing that shows the relationship of the cross-delta route to the proposed gas plant and gathering line facilities that are -- the producers want to establish in the Mackenzie Delta?

MR. GENEST: I think that will be very useful if I can have Mr. Ballem's co-operation I'm sure we can arrange it.

MR. BALLEM: I'm sure we can, Mr. Genest.

THE COMMISSIONER: Yes, Mr. Bayly?

MR. SCOTT: The order of cross-examination I would propose is contained, I think, on page 2 of Preliminary Rulings No. 2. We indicated previously that if there are any persons

who are not major participants who have questions to ask, they can be conveniently arranged if they would be good enough to speak to either MR. Waddell or myself and we will make arrangements for them to put their questions at a time convenient to them and to the other participants.

MR. GENEST: Preferably before the panel has left for the south, Mr. Scott.

MR. SCOTT: We'll do what we can.

THE COMMISSIONER: Yes, Mr. Bayly?

MR. BAYLY: Mr. Commissioner, I just have two points to raise for your consideration, and one has to do with the summaries which your preliminary rulings require the participants to file in advance of the presentation of their witnesses, either as individuals or as panels, and my comments arise out of how this appears to be working or not working.

Now we did receive a summary of this first panel's evidence and I am grateful that M r. Genest has expanded on that. I believe the test he said he was using was to make it so that his grandmother could understand it; but what that has involved is leading from Dr. Mollard evidence that we did not know about in advance. I would hope that if Mr. Genest is going to expand the evidence, to be led from any panel, that he will give us the requisite notice so that we can take it back to our people and

our grandmothers or whoever, so that it can be understood by us as well. I think that is the purpose of the summaries, as you defined them in your rulings, to give the participants the advance notice to prepare for the evidence as it comes outin chief.

The other point I wish to raise was with regard to the cross-delta proposal, and because I noted today that we received the supplementary material on the Fort Simpson alternate route, on the day in which that evidence was given, and I don't fault Arctic Gas for that but on the other hand I would hope there would be some way to make sure that does not happen in any other route changes, and specifically not in the cross-delta route change for two reasons:

(1) That it makes it very difficult at the time of a formal hearing to deal with that and prepare for cross-examination on route changes that we don't know the specifics of.

(2) The other is with regard to the native groups especially, in order to prepare for community hearings it is very important -- and I refer specifically to the cross-delta route - that we have the kind of information that we expect we will find in the supplementary material sufficiently in advance so that we can tell the people in the communities about it, and so that we can plan a sensible schedule for community hearings.

Now I feel we are not able to do that with regard to certain delta communities

until we get this material from Arctic Gas, and I would hope we would get some idea from Mr. Genest of when that will be available. We did first hear about the possibility of a cross-delta route in January, but as yet we have not received anything specific except for the map which you, Mr. Commissioner, have before you today.

MR. GENEST: I think Mr. Bayly's point as to cross-delta is well taken. We appreciate the problems that that creates. It's in a sense self-policing because if we're late with it we're going to be faced with requests for an adjournment and so on, which is something which we would like to avoid, and I hope, as I said earlier, I hope to be in a position later this week to, instead of saying "soon" to be more specific and we are endeavoring to get this into the Commission's hands and into the participants' hands as quickly as possible. But I should have something more definite later this week, sir.

THE COMMISSIONER: If you have -- well, at any rate, when we are up in Aklavik, early in April, we will maybe able to spend a day or two(not the Inquiry -- at least not this whole gang), but we might be able to take a look at that.

MR. GENEST: Well, it certainly changes the impact on Aklavik, for instance, quite dramatically.

THE COMMISSIONER: Well, we'll find that out.

MR. GENEST: That's right.

THE COMMISSIONER: -- in April. That's all then, is it?

MR. GENEST: Well, sir, this summary business is giving me a little difficulty. I thought that Dr. Mollard's exposition was not in the kind of classification of evidence that I should try and spell out word by word. It would be very difficult to do that with Dr. Mollard, with all due respect to him. He always has a lot to say.

(LAUGHTER)

THE COMMISSIONER: Well, it was all worth hearing, I thought.

MR. GENEST: Yes. It's -- and to have a stilted reading, to be bound to every word that I say without asking for explanations, I find it a little difficult. If I catch my friends by surprise, I ask them to be patient with me. I'm going to try with these comments to deal a little more full where I foresee that there will be perhaps explanations required, but if it creates a severe problem or a handicap which I suggest would have to be demonstrated, then of course I will have to pay the penalty and say, "well, you bring these fellows back, so that I can prepare adequately."

I realize what a disorganizing note this puts in the hearing, so I'll bear these comments in mind. I certainly agree that the -- our advance notice of government assessement group concerns was not adequate and I will try and do better in the

future.

MR. SCOTT: Mr. Commissioner, shall we adjourn until tomorrow morning then?

THE COMMISSIONER: Yes, we'll adjourn until 9 A.M. tomorrow.

(PROCEEDINGS ADJOURNED TO MARCH 12, 1975)